MECHANICAL ENGINEERING

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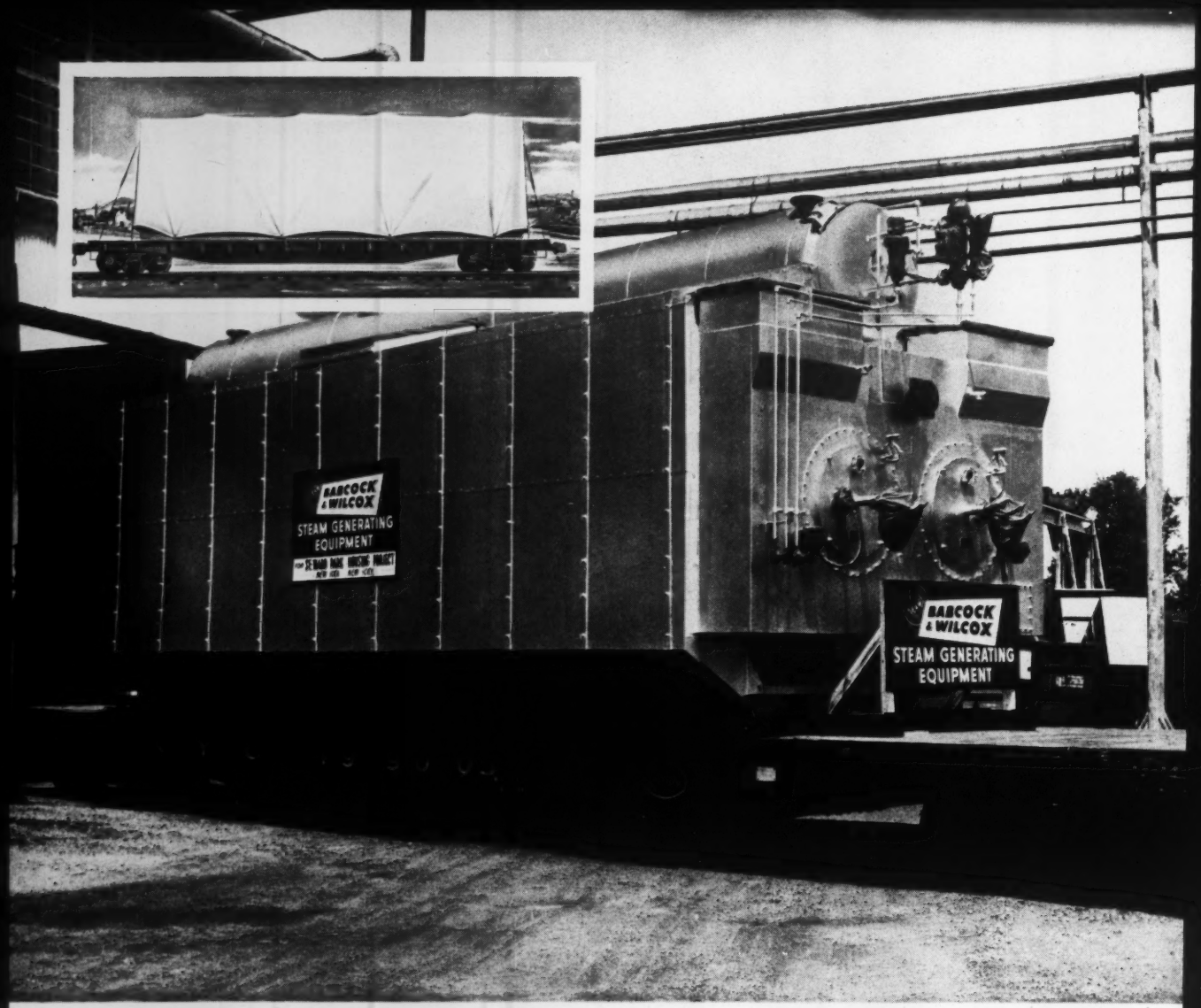
S. Harris



Now: The Wraps Are Off

B&W's FO Package Boiler

This shop-assembled B&W FO Package Boiler—being shipped as a single unit—is on its way to handle an important job.

The FO Boiler will supply all the steam to heat a new $22 million, 1728 family cooperative apartment house in New York City. Simplicity of installation is only one of the FO Boiler's attractive features: just remove it from the flatcar or truck, make the necessary connections, and start it up.

This natural circulation boiler delivers up to 100,000 lb of steam per hour. It's B&W designed, to give you reliable high capacity with minimum maintenance in a small space. If you have a problem involving steam, B&W—with nearly a century of experience in the design and manufacture of steam generating equipment—will be delighted to help you. Just write to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-951-1B

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BOILER DIVISION

CASE HISTORIES

High-volume N/D precision ball bearing with popular Sentri-Seal® gives radial arm saw new sales appeal . . . while lowering costs! Bearing is lubricated-for-life for maintenance-free performance.

Ball Bearings Cut Power Saw Production Costs $30,000 A Year!

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Manufacturer of popular radial arm power saw sought ways to lower over-all production costs, yet maintain high precision standard.

SOLUTION:

N/D Sales Engineer, cooperating with customer engineers, developed and recommended a different rotor and shaft design that maintained original, high motor efficiency. The new design provided for the use of an N/D *high-volume* precision ball bearing. Savings in bearing costs alone add up to $30,000 a year!

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If you're looking for ways to cut production costs . . . or ways to add new sales appeal to your product, why not call your New Departure Ball Bearing Sales Engineer? He can probably engineer a cost-saving, high-volume N/D precision ball bearing into *your* product. Just call or write New Departure Division, General Motors Corporation, Bristol, Connecticut.

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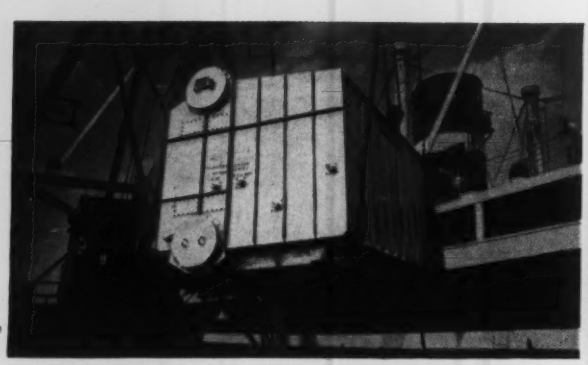
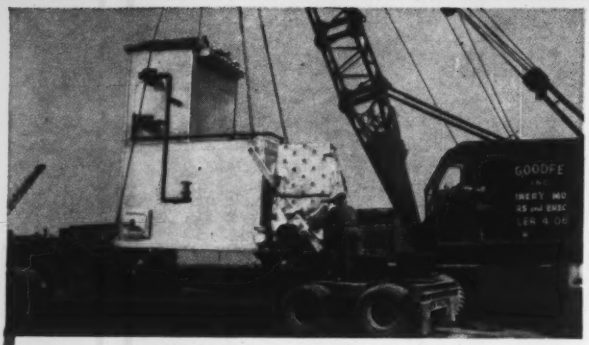
proved reliability you can build around



▲ A C-E Package Boiler, Type VP, en route to Europe. This boiler type is available with capacities from 4,000 to 90,000 lb of steam per hr, with pressures to 700 psi and temperatures to 750 F in certain sizes. It is designed for oil or gas firing. Several hundred of these units are now in service.



▲ A shop-assembled C-E High-Temperature Water Boiler, Type HCC, being unloaded at a midwest manufacturing plant. It is one of two 12-million-Btu boilers used for plant heating. Available for capacities from 10 million to 300 million Btu, this unit type is shop-assembled in sizes up to 50 million Btu for oil or gas firing — up to 40 million Btu for coal firing. Currently, more than 50 HCC Boilers are in service or on order.

▲ A shop-assembled Controlled Circulation Boiler, Type PCC, being prepared for shipment. This type unit is available with steam capacities from 80,000 to 120,000 lb per hr, and with pressures and temperatures to 1000 psi and 900 F. For special applications, designs are available to provide higher steam pressures and temperatures. Seven PCC Boilers are now in service.

NOW

C-E offers LARGER SHOP-ASSEMBLED BOILERS

Three service-proved designs with capacities to 120,000 lb per hr . . . pressures to 1000 psi . . . temperatures to 900 F

The economies inherent in shop-assembled boilers can now be yours even if your steam requirements are as high as 120,000 lb per hr. The C-E line, consisting of three basic unit types, has been expanded to include pressures, temperatures and capacities well beyond normal package-type limits.

The standard, natural-circulation, ***C-E Package Boiler—Type VP***—is now available with capacities to 90,000 lb per hr, and with pressures and temperatures to 700 psi and 750 F.

Where greater steaming capacity is required, or where higher pressures or temperatures are needed for industrial processing or power generation, the shop-assembled ***C-E Controlled Circulation Boiler—Type PCC***—is available. It is designed for the 80,000-to-120,000-lb capacity range, with pressures to 1000 psi and temperatures to 900 F. For special applications, this unit is also available for considerably higher pressures and temperatures.

The C-E High-Temperature Water Boiler—Type HCC—is an ideal type for large space-heating and certain process uses. It is also available in shop-assembled form for capacities to 50 million Btu per hr. It is designed for pressures to about 500 psi, and can provide water at 450 F or higher.

The new, high-capacity ranges of these shop-assembled units represent the logical evolution of familiar and successful designs that have been proved in service for quality, economy and performance.

Catalogs on any or all of these units available on request.

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MECHANICAL ENGINEERING

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THE COVER

Consider the possibilities: Here is electric power for a vehicle, produced directly from the fuel (no intervening machinery), at 90 per cent efficiency (best diesels operate at 40 per cent). Data on this Allis-Chalmers fuel-cell tractor: The fuel, a mixture of gases, largely propane; 1008 cells, 1/4 in. thick, 12 in. square; fuel-cell voltage approximately one volt, open circuit; total output, 15 kw; standard Allis-Chalmers 20-hp, d-c motor; the tractive power, 3000 lb at drawbar on dynamometer. See page 80.

OBLIGATIONS OF AN ENGINEER.....**G. B. Warren** 50

Marvels of engineering surround us; but how often does our profession produce the public leadership expected from men of exceptional talent? ASME's retiring President talks to his fellow engineers.

THE TILT-WING PROPELLOPLANE.....**J. B. Nichols** 52

From the beginning of the airplane, landing has left something to be desired. Now, with the low-weight gas turbine, the vertical-take-off-and-landing plane—not a helicopter—may soon arrive.

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.....**J. H. McNinch, W. W. Vogelhuber, and R. J. McCrory**

Follow the design and development of this single-piston unit that operates with only one basic moving part—the piston. This home air-conditioning compressor may be your first free-piston engine.

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.....**R. W. Bachmann**

As a boy you asked, "What makes it go?" Pursuing this inquiry, you became an engineer. Now you deal with prime movers, driven machinery, and their connecting devices—things that "make it go."

A MODEL LAW FOR PROFESSIONAL ENGINEERS.....**W. H. Larkin** 70

Because engineer's work affects the safety, health, and property of the public, every state limits the practice of engineering to registered engineers. The Model Law grows with the profession.

DESIGN STUDY OF A 300-MW ORGANIC-COOLED REACTOR..... 72

.....**R. Balent, G. H. Bosworth, and J. Plawchan**

Two years of operation of the Organic Moderated Reactor Experiment have confirmed the technical feasibility of the organic-cooling concept. Advantages: Simple design, low cost, inherent safety.

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TUBE-TURN *Bellows Expansion Joints are test rated on basis of minimum cyclic life.*

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Bellows Expansion Joints test rated for assured cyclic life

Tube Turns has introduced a brand new concept in bellows expansion joints to fill a vital need in engineered piping systems.

These new bellows joints are rated on the basis of thorough, well organized test studies to *assure a definite minimum cyclic life*... rather than the usual average or maximum. This conservative rating, backed by Tube Turns' extensive test results, gives you an assurance of *confidence* heretofore lacking in the application of bellows joints.

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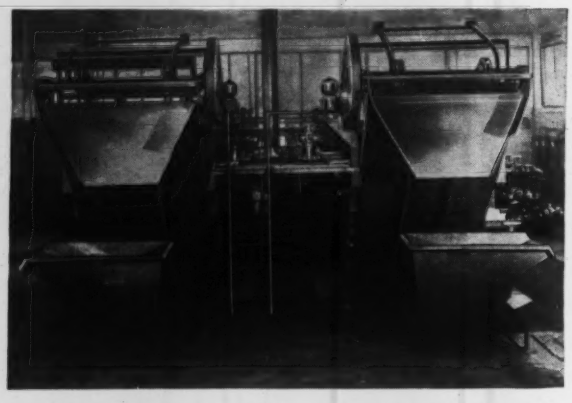
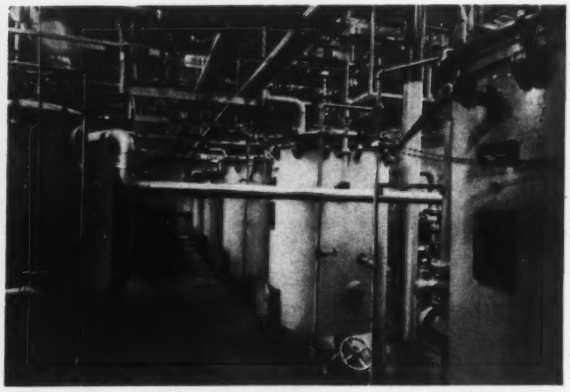
Today's high production costs dictate a good hard look at metalworking tools and techniques—make a reduction in operating expenditures essential to increased profit margins. Here are typical examples of companies which have obtained maximum production from machine tools by eliminating unnecessary and often hidden expenses through the use of Hoffman filtration equipment.

They're Beating High Machine Tool Costs and Obsolesence



A Hoffman Central Flotation System serving 28 grinding machines at an International Harvester plant. The coolant serving the sickle grinding department is a water-base soluble oil.



A Hoffman Central Filtration System consisting of 9 Hoffman Pressure Filters, Model I-80S, each equipped with Hoffman Dual Magnaflo Plates—with a flow rate of 150 gpm and sludge collector conveyor—(Magnetic separator), are shown at the plant of a leading automotive and aircraft accessory manufacturer.

This system enabled International Harvester to make the following savings:

Cleaning of coolant trenches completely eliminated —savings of $10,000 annually.

Trucking costs for the removal of sludge to a disposal point reduced 65.5%. Saves $8,122.50 annually.

Cost of grinding wheels reduced 47.4% — saves $65,477.19 annually.

Production per grinding wheel increased 134%.

Cost for wheel-change-over reduced 57.3%.

Adding these and others, the total savings for this particular year were significant.

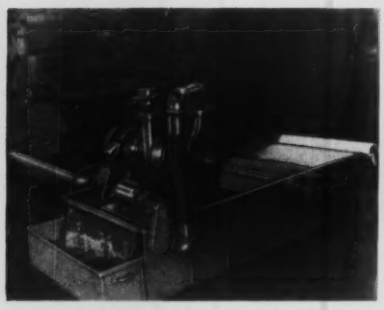
The following tabulation is a percentage breakdown of actual savings made with this Hoffman Central Filtration System equipped with a Magnetic Separator and sludge collector conveyor for automatic removal of sludge collected by filters, magnetic plates and gravity settling.

Grinding Oil 2.5%

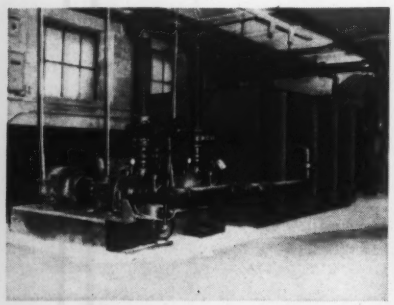
Diamonds—Grinding Wheels 43.4%

Production scrap (resulting from improved quality of product) 32.5%

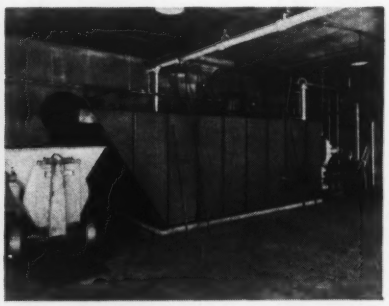
Labor to operate system and actual production labor @ $2.00 per hour 21.6%



A Hoffman Vac-80 Vacu-Matic Filter is shown installed on a Norton 30" diameter stepped-wheel grinder for grinding transmission shafts at the Syracuse plant of a large automotive manufacturer. Most Norton grinders are equipped with Hoffman Vacu-Matic filters when shipped.



At the Union Twist Drill Co. in Athol, Massachusetts, a Hoffman Magnaflo Separator removes metal particles from oils and coolants to solve numerous clarification problems. Result—many money-saving improvements in manufacturing technology and product quality.



A money-saving Hoffman Flotation Unit at the Fafnir Bearing Company. It is designed for plant wide distribution of water-base coolant. The company credits Hoffman systems for great improvement in critical finish grinding operations on bearing races.

The Day Maximation Began

In seeking ways to increase efficiency, production men in the metalworking industry have found elimination of hidden machine tool costs through the use of proper filtration equipment a virtual guarantee of maximum output and economy. This method of obtaining increased production rates is known as *maximation*. Although today, it is one of the most significant factors in determining metalworking profit ratios, the maximation theory and its initial applications were actually developed more than 20 years ago.

HOW MAXIMATION STARTED

A number of months after inspection and delivery of several thousand piston rings to an airplane engine plant, the manufacturer was told that the rings were unsatisfactory and would be returned. Metal particles in the coolant apparently had adhered to the rings during the lapping process and the original high polish finish on the inside of the rings was pitted and chipped on removal from storage. About this time, engineers from the U. S. Hoffman Machinery Corp. were pioneering in research and development of dry cleaning principles for the removal of metal from kerosene coolants. Asked to provide a solution to the problem, they designed a pressure filter system for the clarification of coolants.

THEN AND NOW

This first filtration equipment by Hoffman was a fantastic complex of pipes and valves. But it did a fine job of bringing clean coolant to the work. A few months later, Fafnir Bearing asked for 2 pressure filters "just like the original." From these pioneering concepts have come Hoffman's modern equipment. Today, Fafnir Bearing employs more than a dozen advanced Hoffman individual and central filtration systems.

At Fafnir and in thousands of other plants employing filtration, coolants and lubricants once contaminated by metallic chips, abrasives and other extraneous dirt are no longer responsible for high production, maintenance and costs, as well as premature obsolesence. Through proper filtration, machines originally designed and tested for peak efficiency with clean lubricating oil and clean coolants can now operate at or near rated capacity. Filtration has made it possible to obtain a 30 to 50% savings in grinding wheels, honing stones, broaches, cutting and other edge tools in addition to providing numerous collateral benefits and advantages.

TYPES OF FILTRATION EQUIPMENT

In making recommendations for solving filtration problems, Hoffman engineers draw on a complete line of equipment which includes;

PRESSURE FILTERS—This type of filter gives up to 100% clarity and is widely used with grinding, cutting and honing oils as well as water soluble oil coolants where finest clarity is consistently required. Easily adapted for large groups of machines. Unlimited coolant capacity.

FLOTATION EQUIPMENT—Automatic flotation units increase the productivity of machine tools and eliminate down time for sump cleaning. Provide excellent results in steel and cast iron applications with efficiencies of over 98% in one pass. Handles flow rates from 40 to 1500 gpm.

MAGNAFLOW SEPARATORS—Fully automatic and self-cleaning, Hoffman Magnaflo Separators remove from 75% to 90% ferrous solids from cutting oils and water soluble coolants. Flow rate from 40 to 1,000 gpm.

VACU-MATIC FILTERS — For continuous filtering of coolants from *individual* machine tools. Provides unusually high flow rates in continuous filtration of water soluble coolants. Completely automatic and self cleaning. Flow rates range from 40 to 2,500 gpm.

DISC FILTERS — Filter oils containing finely divided particles. Geared for continuous flow.

SUCTION FILTERS—Provide fine filtration on small flow rates for lapping, microhoning, grinding and similar operations. Cap.5-60 gpm.

SUMMING UP

Proper filtration delivering clean coolant makes it possible to achieve maximation with these savings.

- Greatly reduced down time
- Higher speeds
- Improved finishes—fewer rejects
- Longer useful life of coolants
- Life of edge tools extended
- More sustained tolerances
- Fewer stoppages, adjustments
- Scrap loss considerably reduced
- Elimination of motor pumps
- Curtails bacteria and rancidity
- Saves 25 to 50% in grinding wheels, honing stones, broaches, individual machine tools.

To check on the unlimited industrial applications of individual tool and complete central filtration systems, send for free bulletins and case histories on equipment described above.

Please write:
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Dept. LR, Industrial Filtration Div.
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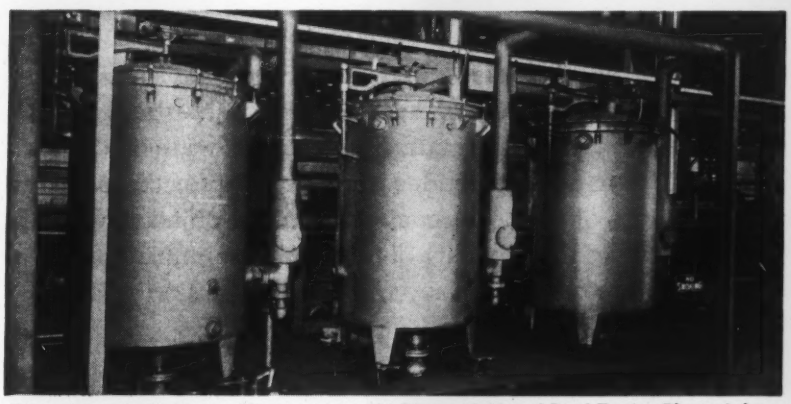
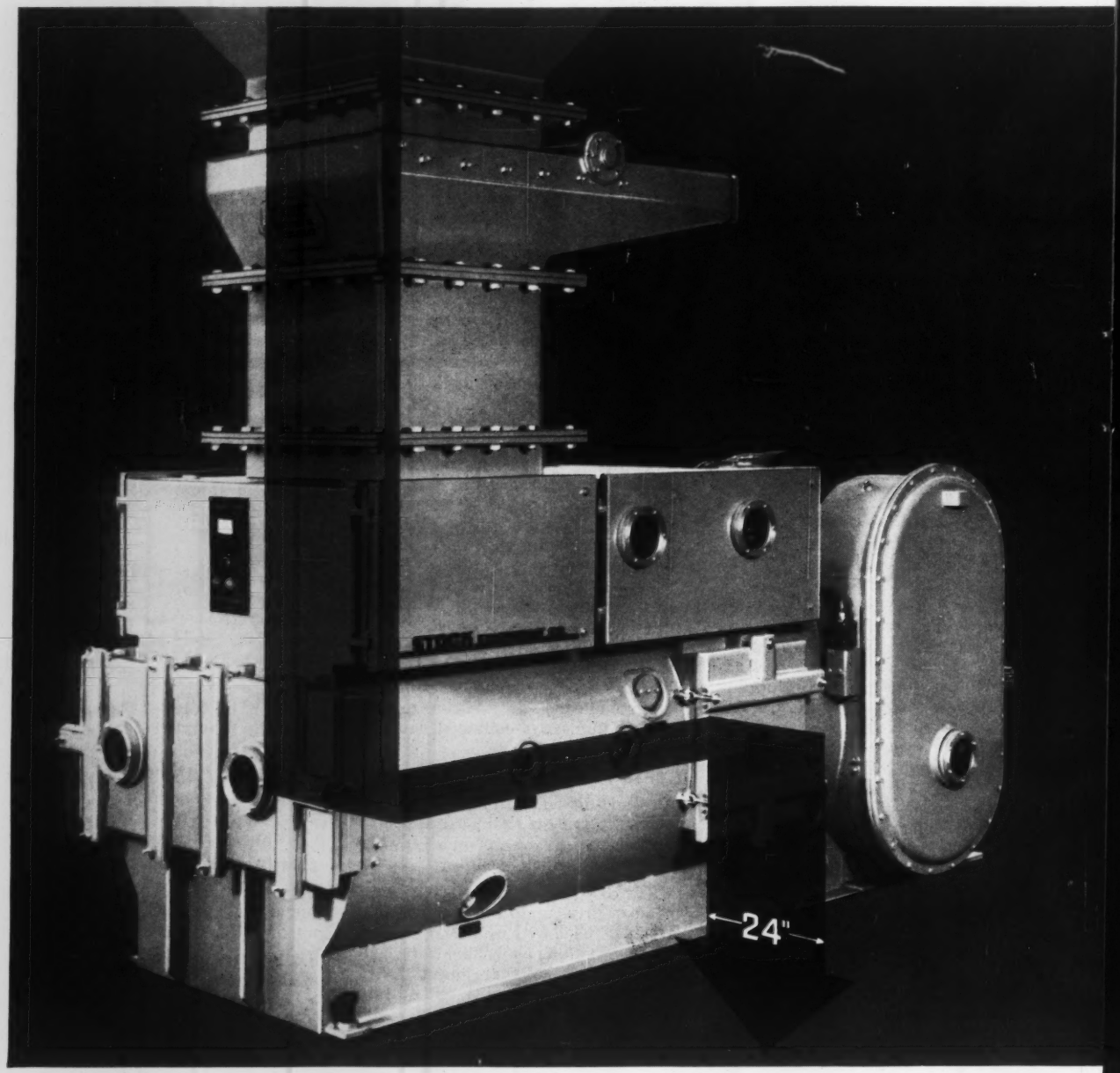
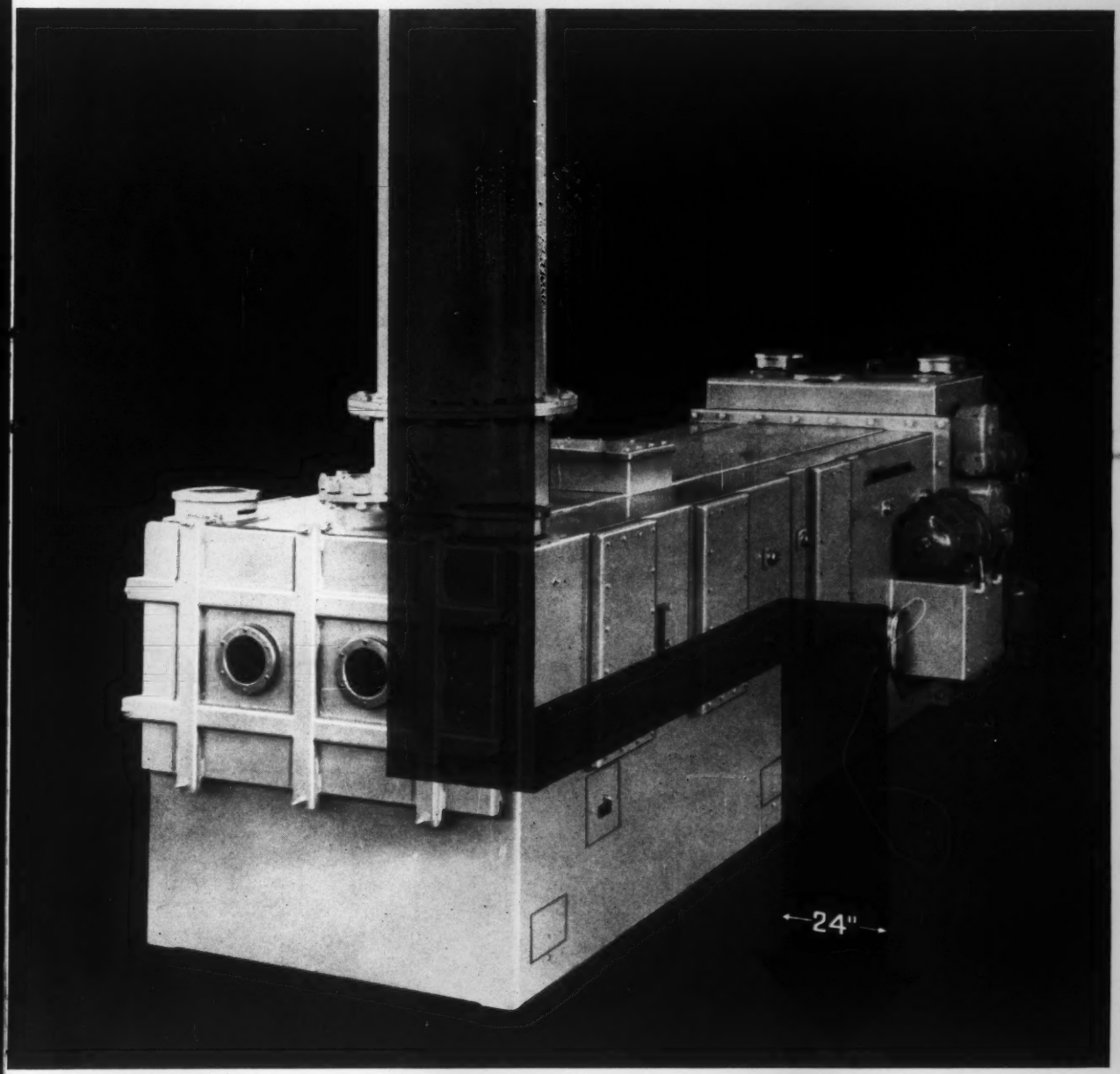


View of a central pressure filter system at the Plymouth Mound Road Engine Plant of the Chrysler Corp. This system serves a wet grinding department.



S-E-Co. Volumetric Feeders and S-E-Co. Gravimetric Feeders assure maximum reliability of coal feed to pulverizers and to cyclone burners because they carry the coal 24" wide on the feed belt. The 24" clear width provides ample space for the passage of oversize pieces of coal or occasional foreign objects. Not only does this contribute to reliability of feed, but it minimizes fluctuations in the volumetric efficiency and correspondingly leads to

24" WIDTH OF COAL ON BELT



a more uniform discharge. Carrying the coal in a 24" wide stream on the feed belt also means that wet, sticky coal is handled with the same ease as dry coal. It is the unobstructed 24 inches that provides the best assurance of uninterrupted feeder operation.

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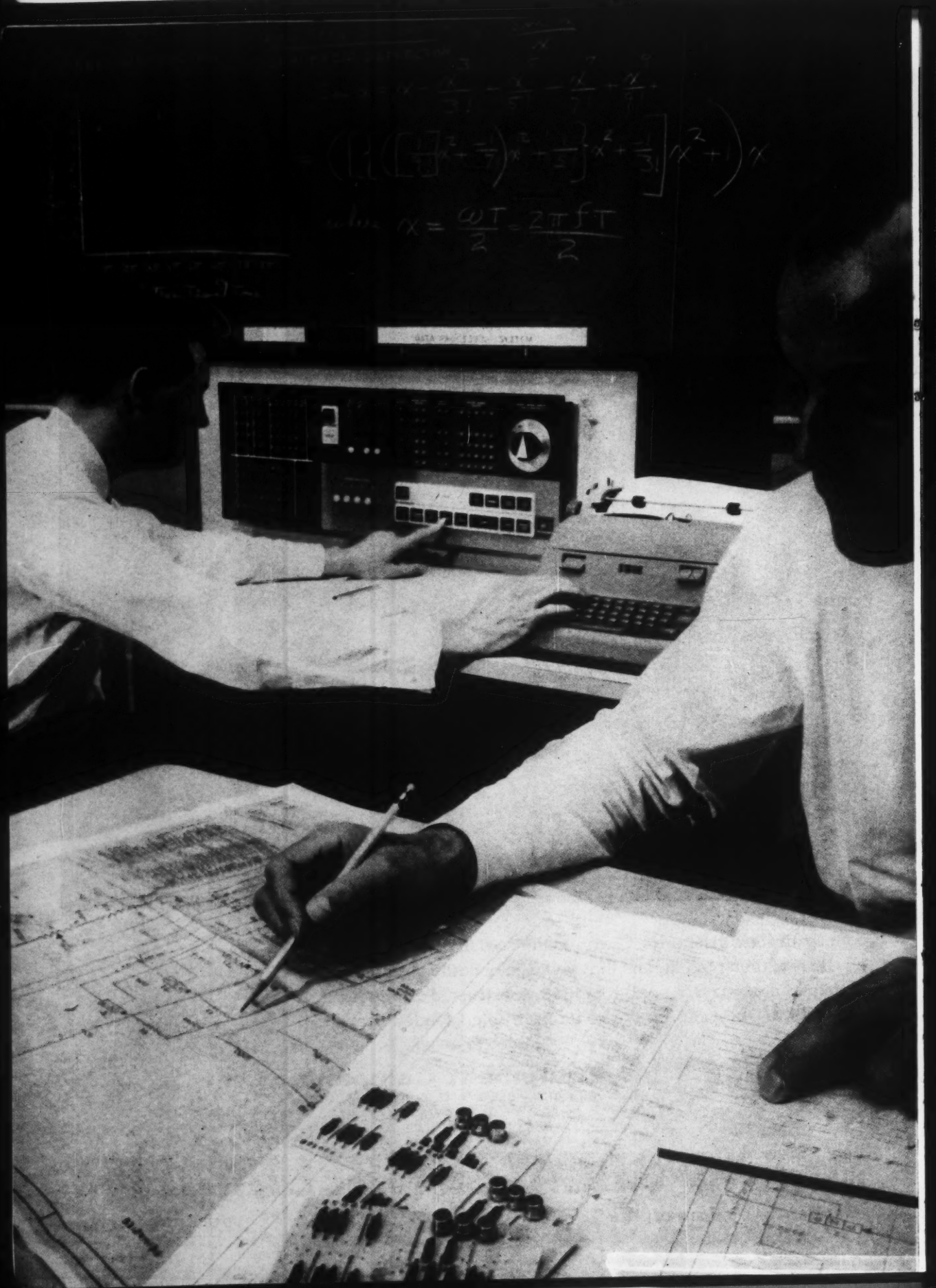

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IBM® 1620

first solid state engineering computer in the low-price field

Here is a new and powerful stored program, desk-size computer designed to bring more computing ability to engineering problems at low cost.

Transistorized throughout, the IBM 1620 is the only solid state, core-storage computer in its price class.

Easy to learn—easy to operate—easy to communicate with—this powerful computer relieves engineers from routine calculations—frees them for creative tasks.

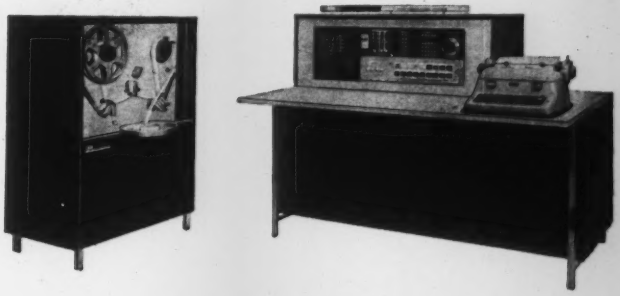
Data is fed into the 20,000-digit magnetic core memory of the 1620 via punched paper tape. Alpha-numeric output is printed at the console typewriter in desired format, under stored program control.

This new computer with its two-address instruction format and variable field length, gives you up to 50% more storage capacity than a fixed word-length system.

All notations of input and output are in the decimal system. An unlimited decimal field and internal self-checking assure accuracy. A powerful two-address instruction format adds to the 1620's timesaving capabilities.

Programming is simplified through the use of IBM Fortran—a mathematical programming system which compiles machine instructions from algebraic and English language notation. A library of programs for standard engineering computations will also be part of the 1620 package.

Call your IBM representative—ask him to show you all the unique features of the IBM 1620. Like all IBM data processing equipment, this system may be purchased or leased.



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NEW LOOK IN NUCLEAR SUBS . . . The Navy's new submarine Skipjack, built by General Dynamics Corporation's Electric Boat Division in Groton, Connecticut, features a revolutionary blimp-shaped hull and diving planes on the sail (formerly known as the conning tower). Although her speed is classified, Skipjack is the fastest of the A-Subs.

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Steel and Tubes Division

STEEL • TUBES U.S. PIPE DIVISION

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"HYDROFORGED" FINE-GRAIN STAINLESS PIPE FOR THE NUCLEAR NAVY*

THE PROCESS: The starting point is a high quality machined hollow billet made centrifugally which is cold expanded by hydrostatic pressures up to 50,000 PSI in specially designed massive metal dies. After "hydroforging", the pipe is given a recrystallizing anneal which results in the grain refinement characteristic of wrought stainless steel.

THE PRODUCT: After final machining of the O. D. and I. D. surfaces to 125 micro inch finish, the pipe is subjected to all the testing requirements of Military Specification MIL-T-18063A (Ships) which covers seamless austenitic steel tubes and pipe intended for radioactive system service. This specification includes: chemical analysis, tensile properties (for Type 304 stainless steel—75,000 PSI minimum tensile strength, 30,000 PSI minimum yield strength, 35% minimum elongation), expanding and flattening tests, hydrostatic pressure test, intergranular corrosion test, macro-etch, ultrasonic and liquid penetrant examination.

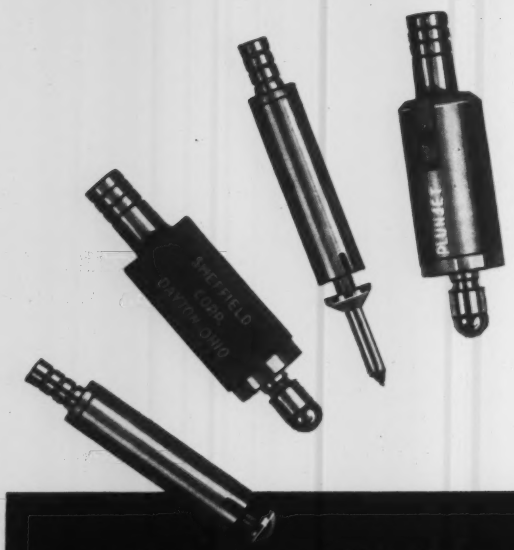
*** U. S. NAVY SERVICE APPLICATIONS FOR HYDROFORGED STAINLESS INCLUDE:**

Pipe for valve operating system reservoirs and primary water preheaters

Primary coolant piping for nuclear submarines and surface ships

Seamless welding fitting stock for large diameter reactor piping systems for submarines and surface ships

Demineralizer shells



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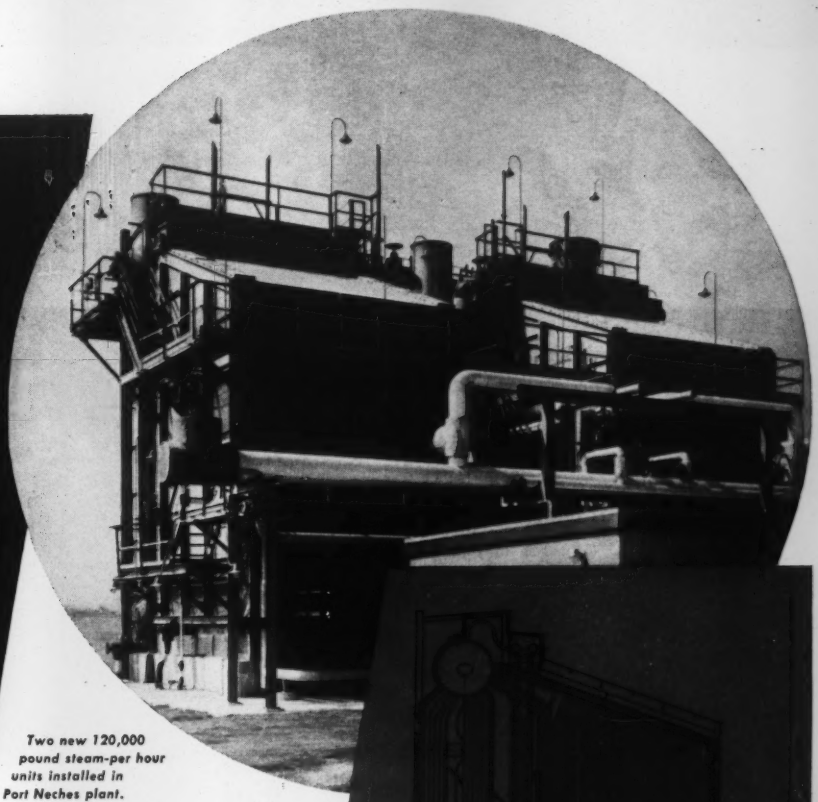
Steam for Jefferson Chemical by Vogt



Two new 120,000 pound steam-per hour units installed in Port Neches plant.

The needed additional power and process steam capacity for Jefferson Chemical's expanded Port Neches plant is furnished by the two Vogt boilers pictured here, each with a capacity of 120,000 pounds per hour. The boilers are designed for 675 lbs. pressure to operate at 625 lbs. pressure and 769°F. total temperature. The furnaces are equipped with gas burners and have water cooled front and side walls.

Bulletins describing Vogt boiler installations in a variety of industrial plants for power, processing and heating are available on request.

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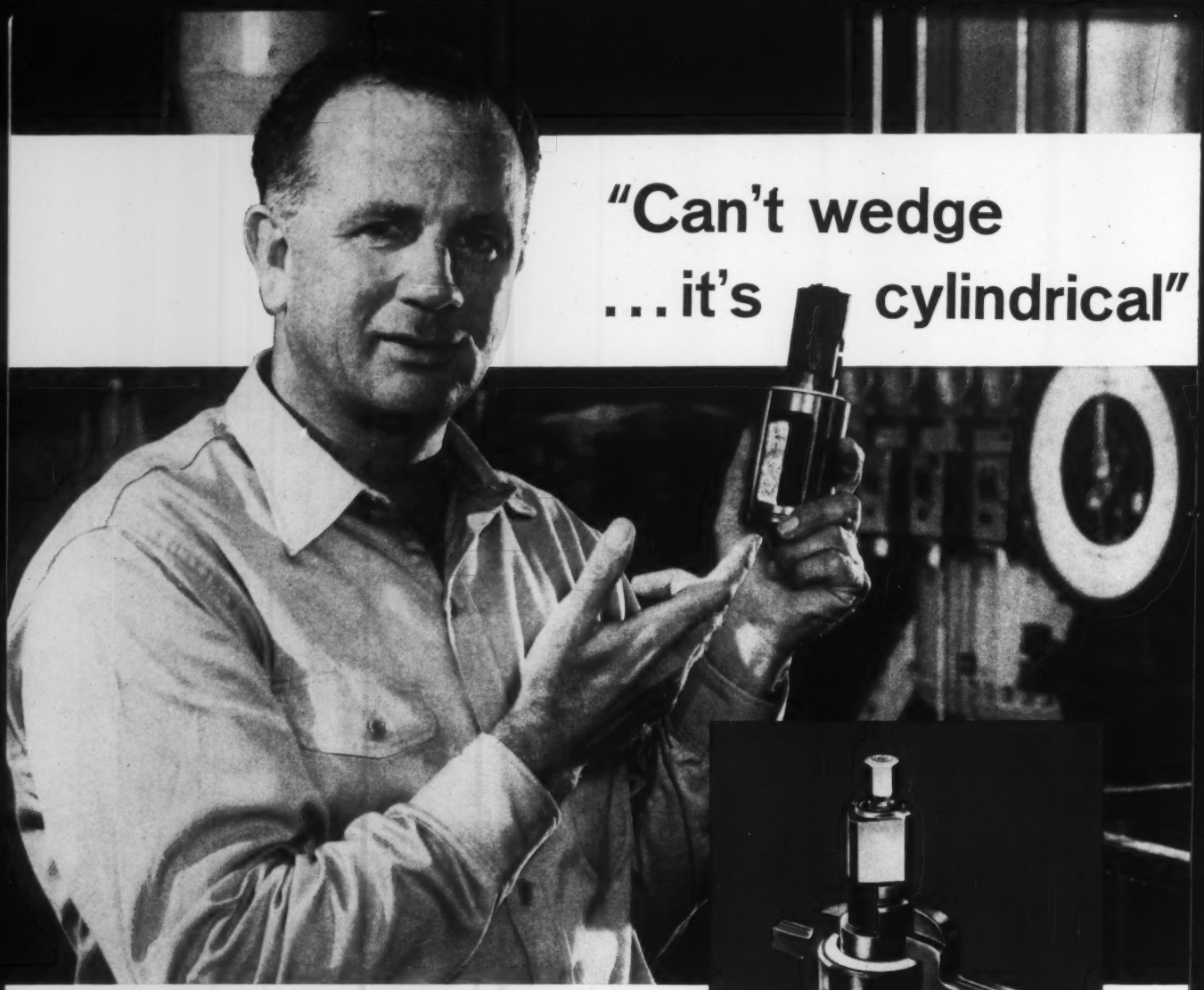
STEAM GENERATORS



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There's no taper to cause sticking or wedging in an ACF valve. And the plug can't be unseated.

The baseplate spring and line pressure hold the plug tight against the Teflon head seat gasket. All friction surfaces are constantly lubricated for easy quarter-turn operation and protection against corrosion.

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ACF semi-steel lubricated Plug Valves are available in rectangular, round, diamond, and V ports; venturi, multiport and steam-jacketed models.

Materials: steel, semi-steel, Ni-resist, carbon steel, bronze, aluminum.

Sizes: ½" through 30".

Working Pressures: 125 through 800 pounds.

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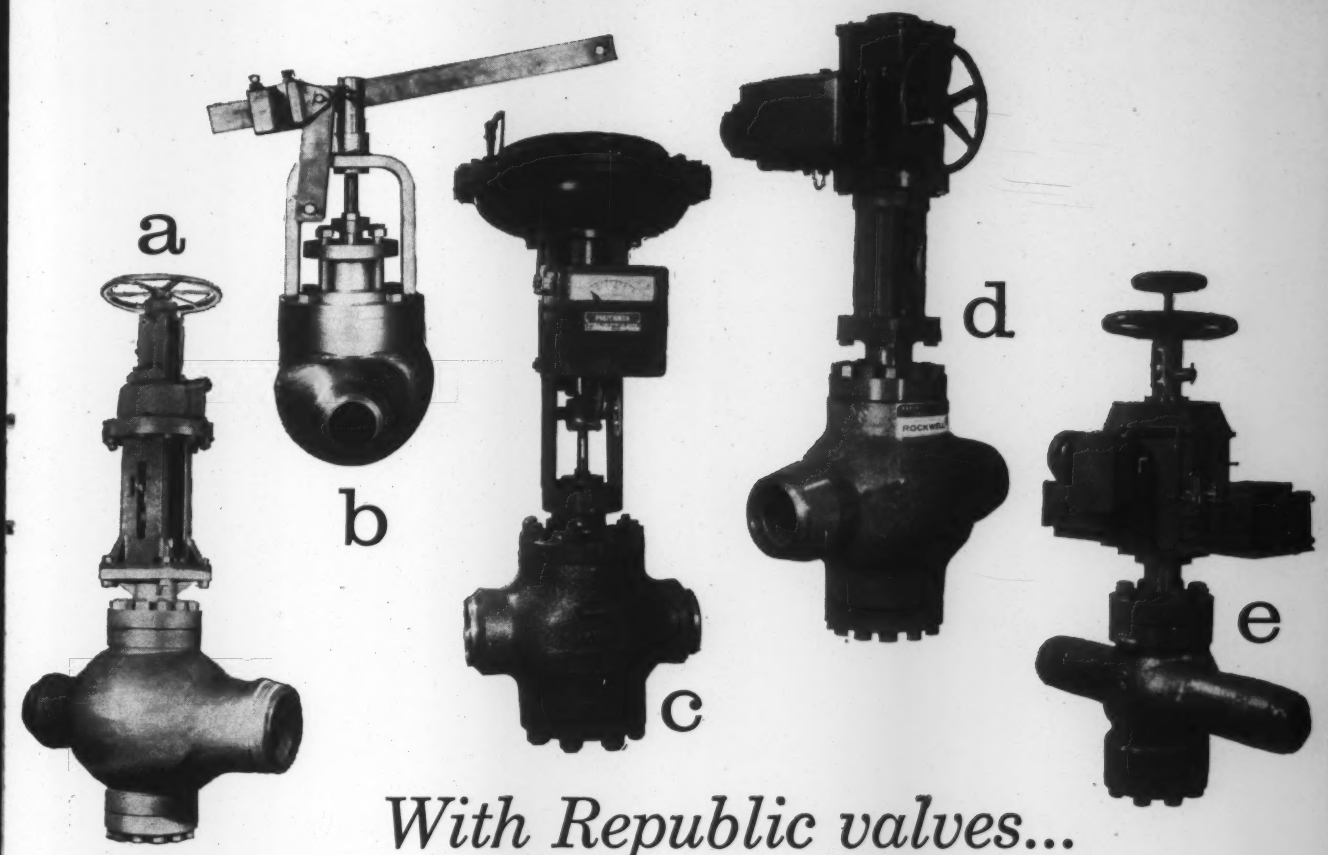

With Republic valves...

You get longer life, less maintenance

For over 35 years Republic valve developments have paced the changing demands for more sturdy valves by the most progressive utilities and industries. For such services as pump recirculation control, feedwater regulation, steam pressure reducing and high pressure water control, Republic valves have established a reputation for durability, long life and trouble-free performance.

Superior valve design—Republic research into the causes of valve noise and vibration, and also the wear resisting and galling properties of materials has resulted in a modern line of Republic valves of advanced design. Republic valve contours are designed to produce not only the desired regulating characteristics but also to reduce erosion damage and noise as well. Extra large guide bushings, extra deep stuffing boxes, solid plug inner valve construction, plus precise manufacture and long-life materials make Republic regulating valves perform better, last longer, with less maintenance.

Wide selection of valves and features—Rockwell-built Republic regulating valves shown on this page are representative of the complete Republic line:

a. **Cylinder operated valve**
b. **Lever operated valve**
c. **Diaphragm operated valve**
d. **Motor operated valve**
e. **Toggle head operated valve**
f. **Diaphragm operated angle valve**

And, for many special applications, such Republic accessories as pneumatic and electric valve positioners for hysteresis-free control, and a complete line of controllers are available.

Whatever your regulating valve problem, let Republic engineers put their years of application experience to work for you. For additional information, see your Republic representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois.

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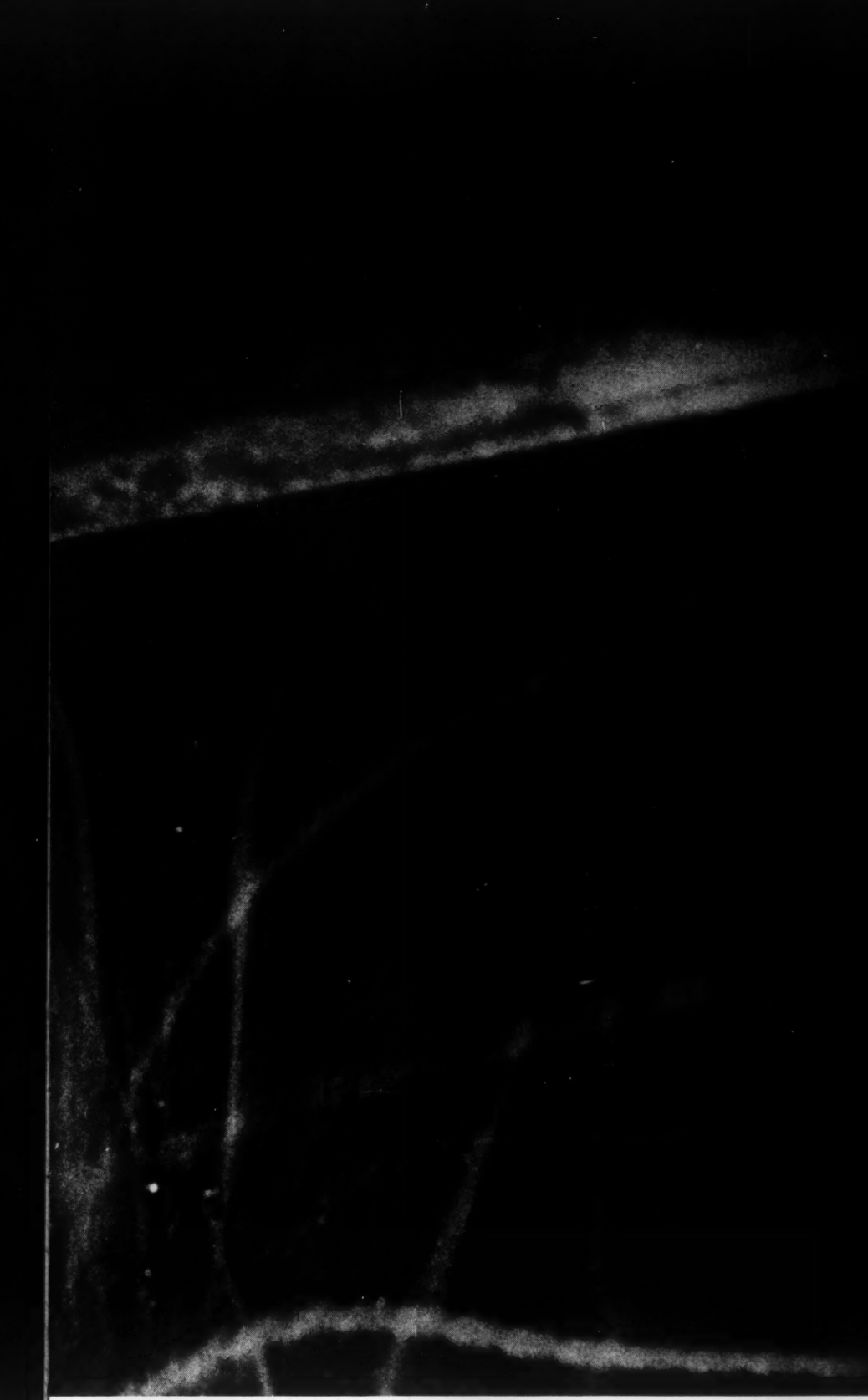
ROCKWELL

Jointly, We've come a long way since man first found that he could unite pieces of metal by

No matter what technique you use, the finished joint is best when the welded material is steel.



beating them together while they were hot. Now there are almost 40 different welding techniques.

Above, you see a close-up photograph of arc-welding. For a more complete picture of welding, turn the page. ▷ ▷ ▷

STEELS FOR DESIGN

Stainless Steel makes a flawless milk can—Milk cans have to be surgically clean. That's why the John Wood Company makes them from Stainless Steel, with **welded** joints. Here, you see a "Heli-arc" welding machine that was specially designed to weld the inside bottom and outside bottom of the can in one operation. The welding head is retracted to the breast of the can where again, the inside and outside welds are done in one operation. A nipple is gas-welded to the bottom of the can and all the joints are polished to a mirror finish—ready to pass microscopic inspection. Because of the outstanding design and fabrication processes developed by this company, they are now equipped to produce 50% of all the Stainless Steel can requirements for the entire dairy and vending machine industries.

USS "T-1" Steel stops saddle block failure—A saddle block links the dipper stick to the boom of a power shovel (see arrow above) and provides the digging effort. It has to withstand tremendous stress and shock—failures are not uncommon. But one operator had too many saddle block replacements so he asked J. B. Lund's Sons Co. to make a stronger unit. The conventional solid cast steel or forged steel block would have been too vulnerable, so the additional strength had to come from a **welded** assembly of strong steel plates. But the higher carbon content that increases the strength of most types of steel also decreases the weldability. They solved the dilemma with USS "T-1" Constructional Alloy Steel. "T-1" brand is a **low** carbon, quenched and tempered alloy steel with tremendous strength—100,000 psi minimum yield strength. The photo shows the finished block made from "T-1" steel plates that were edge-welded 1¼" deep. This block has never failed.

High Strength Steel cuts dead weight—You can stand beside the Carquinez Strait in California and size-up thirty years advancement in bridge building. There are two spans there, side-by-side; one is 31 years old, the other was completed last year. The builders of the new span saved 2,128 tons of steel because they designed the new Carquinez Strait Bridge with USS TRI-TEN High-Strength Low-Alloy Steel and USS "T-1" Constructional Alloy Steel. With yield strength levels of 46,000 psi min. and 90,000* psi min., respectively, these ultra-strong steels permitted thinner, lighter truss members that were shop-welded instead of riveted. 100% efficiency butt welds saved 20% in the weight of tension members by providing extra material at the holes for the connection bolts. The smooth, rivet-free surfaces are less vulnerable to corrosion . . . save thousands of dollars in maintenance.

USS, "T-1" and TRI-TEN are registered trademarks

United States Steel USS

*Now 100,000 psi for plates up to 2½ inches.

Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

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Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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VERTICAL BASE MOUNTED OPTIMOUNT RATIOMOTOR drives agitator blade shaft on pigment mixers in coated textiles plant. Manufacturer says: "OPTIMOUNT adaptability permitted simplified, efficient design for our specific needs . . . at a much lower cost for the complete installation."

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Vertical or horizontal base mounted — for any floor, wall, or ceiling mounting position — choice of many shaft positions in either base — single or double reduction helical gearing — for ¼ to 10 hp drives. Sold also without motor, ready for attachment of separately purchased motor of your choice.

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In central stations functioning 24 hours every day, a major Kellogg responsibility is to install and weld the hundreds of feet of heavy-walled main steam lines that keep steam flowing to the turbines, as well as much of the auxiliary piping.

Through Kellogg's metallurgical background and the company's development of special field-welding techniques, the security of Kellogg K-Welds® on stainless, chrome-moly, and high quality carbon steel piping is assured for the life of the steam generating system.

Kellogg's role in the erection of one major utility's newest power station is fully described in the 12-page booklet—"The Eddystone Story." Inquiries for this booklet are invited from consulting engineers, engineers of power generating companies, and manufacturers of boilers, turbines, and allied equipment.

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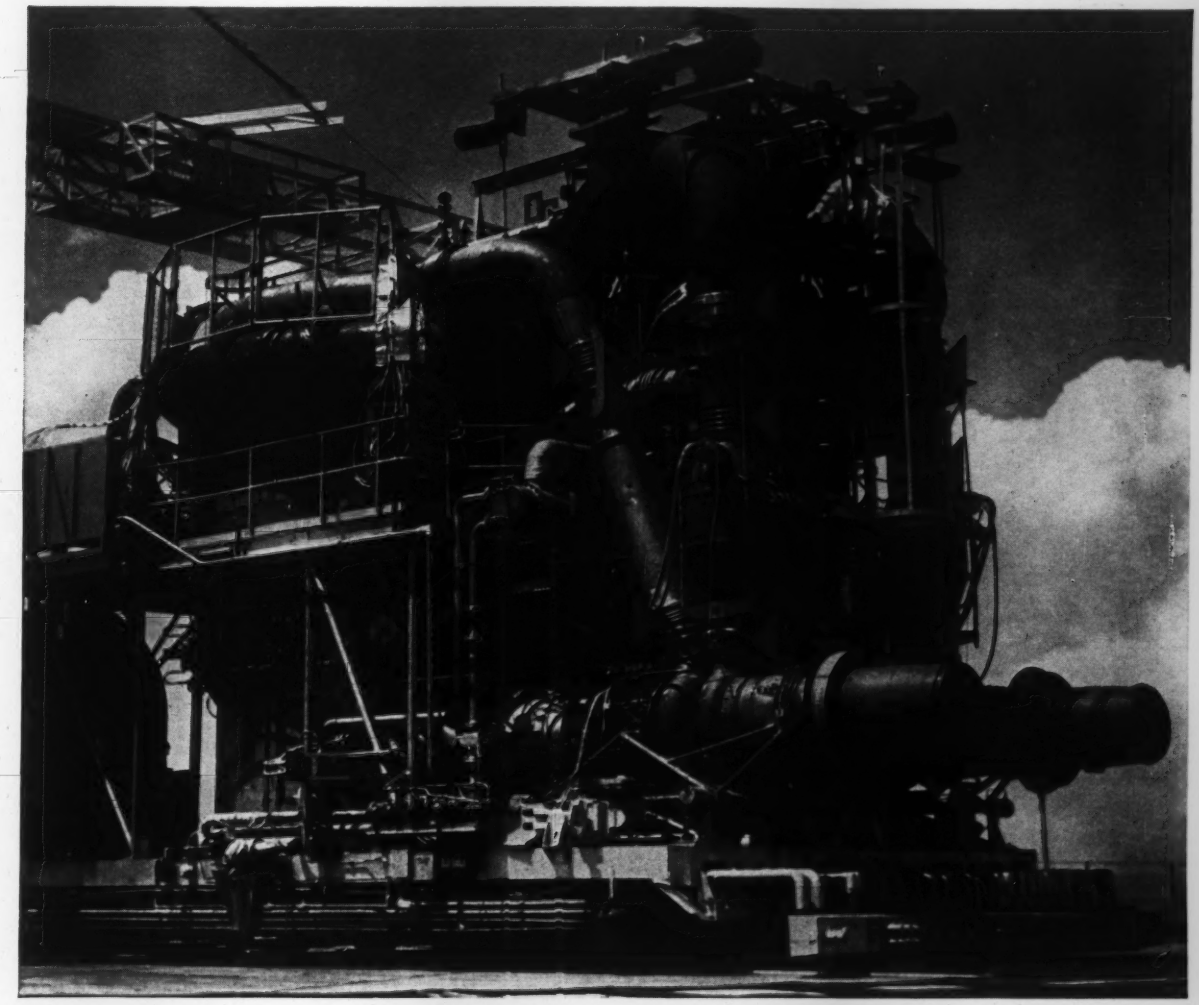

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Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

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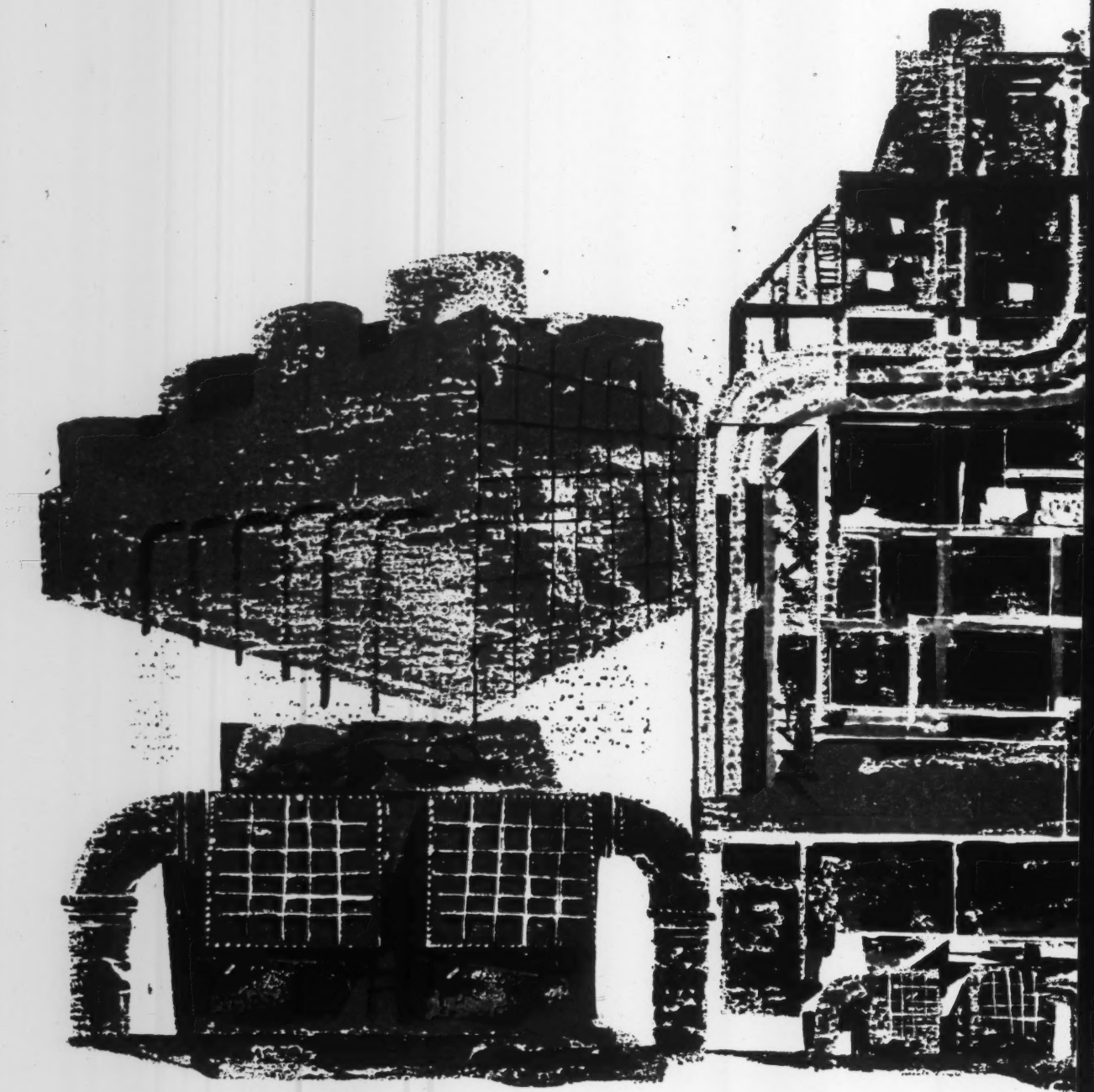
Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS



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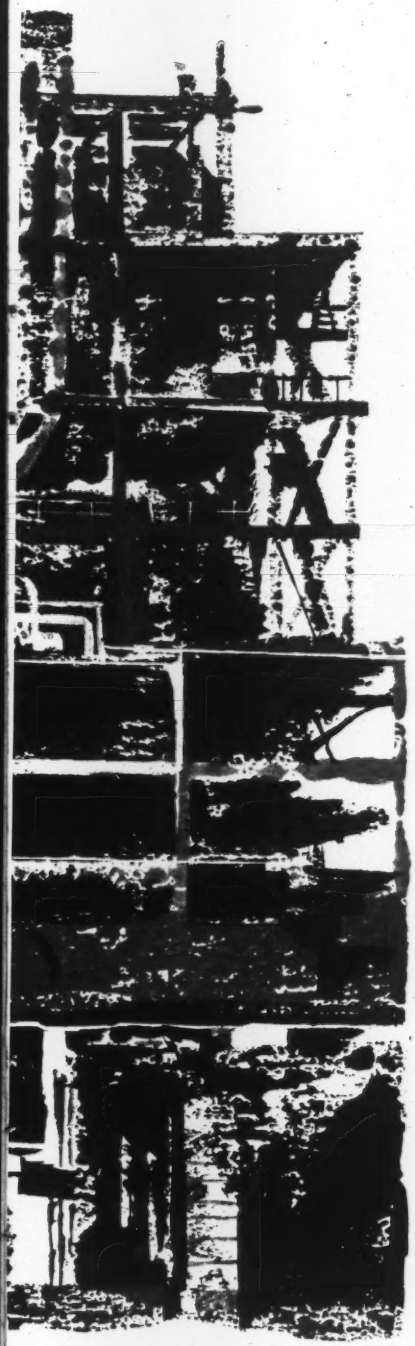

The one kind of engineering every plant needs

You may use heat to produce steam, electricity, or chemical reactions—but if you use it for any industrial purpose at all, heat is probably one of your major items of operating expense. There's also a good chance that heat is costing you more than it should.

That's because every piece of equipment that uses heat—be it a steam generator, heat exchanger, or simply piping—is a potential weak spot in your budget unless it is engineered to get the *optimum* out of the heat-dollars you put into it. At Foster Wheeler, getting the *most* out of heat is expressed as *Heat Engineering.*

Heat Engineering is the reason you'll see FW-built equipment in such critical places as nuclear power stations, on the world's largest and most efficient tankers and naval ships, in giant steam-electric plants, and refineries and chemical process plants of all types and sizes.

If your company is contemplating *any* modernization, expansion, or replacement where heat is concerned, why not check into the difference *Heat Engineering* can make? Contact Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.

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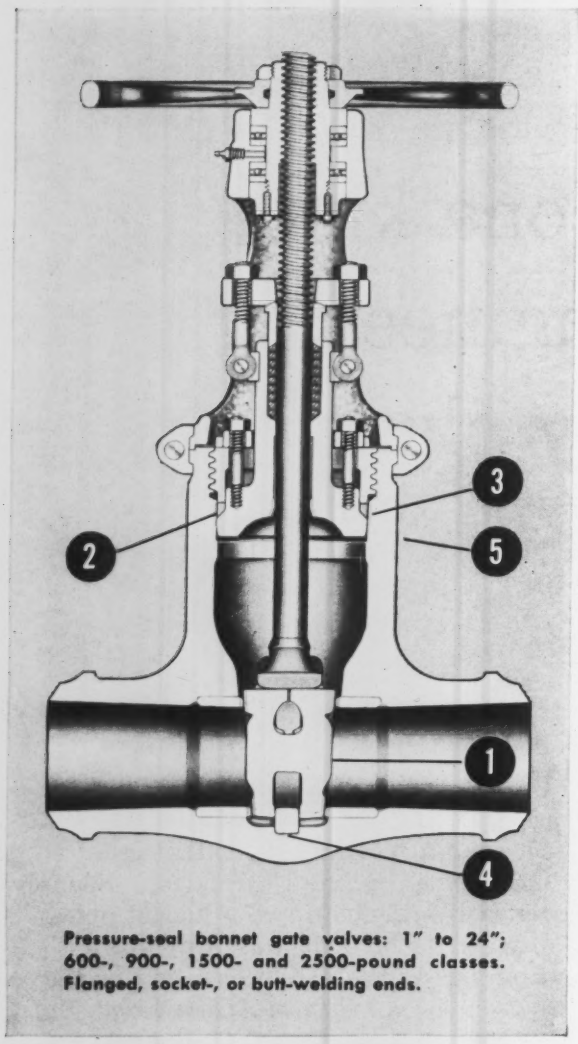


Pressure-seal bonnet gate valves: 1" to 24"; 600-, 900-, 1500- and 2500-pound classes. Flanged, socket-, or butt-welding ends.

Note these Features

❶ **Flexible wedge disc prevents sticking.**

❷ **One-piece, silver-plated seal ring remains freeze-free for easy dismantling.**

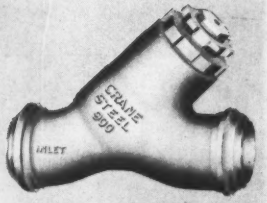
❸ **Wear-resisting stainless steel inlay prevents corrosion at this critical point.**

❹ **Full-length disc guides prevent wear and drag on seating surface.**

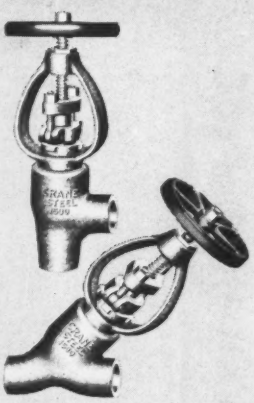
❺ **Design saves up to 60% of weight of bolted bonnet valves.**

ALL CRANE PRESSURE-SEAL BONNET VALVES ARE ASA-RATED

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957 as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.



New globe lift-checks. Feature only two internal parts: cage-type disc and liner. 900-pound class, 3" to 12"; 1500-pound class, 2½" to 12"; butt-welding ends. Stop-checks available also.



Globe and angle valves. Globe valves of Y-pattern design in all sizes; interior areas shaped to decrease turbulence, reduce pressure drop. 1" to 16"; 1500-pound class; socket- and butt-welding ends.

Modern controls for steam stations...
Crane pressure-seal bonnet gate valves

Here is the most modern valve designed for high-pressure/high-temperature service. Bonnet joint leakage is eliminated. Weight is reduced without sacrificing strength and safety. Its streamlined contour simplifies insulation. Easy accessibility provides for quick, in-line servicing. Critical points of wear are protected by special metals. These and other advantages assure trouble-free service with minimum maintenance.

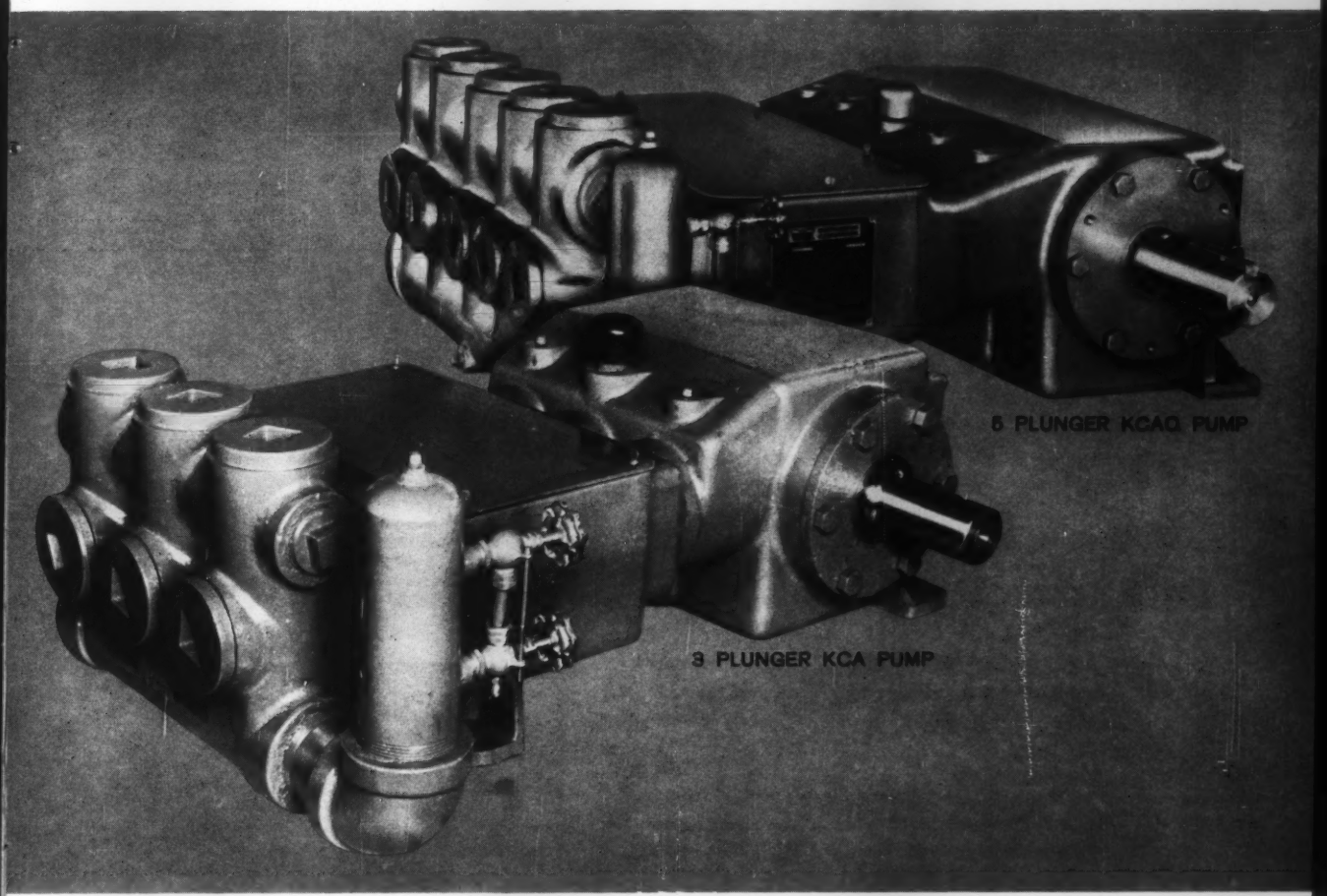
For complete facts about this gate valve and all other valves in the *expanded and improved line* of Crane valves for power plant service, see your Crane Representative.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

YOU CAN SAVE UP TO 53% WITH THESE HORIZONTAL HIGH PRESSURE PUMPS



Before you buy a high pressure pump for your hydraulic application, see Worthington's new KCA and KCAQ pumps. You can depend upon these two new pumps to give you highest capacity and most pressure at truly low prices.

These horizontal power pumps save you up to 53% on initial cost. Some of the many applications for the KCA and KCAQ units include hydraulic presses and shears, steel mill roll balance, die casting, boiler feed service, descaling, cleaning and washing, fog spraying, hydrostatic testing, and rifle drilling coolants.

The KCA and KCAQ pumps have 6 outstanding features:

1. Meets wide range of conditions. Plunger diameters can be varied from 1¼ to 2½ inches.

2. Fewer Spares to carry—Wearing parts interchangeable between KCA and KCAQ pumps.

3. Many "extras" included as standard such as solid ceramic or Colmonoy plungers, suction air chamber to minimize noise and pulsation, plunger packing and stuffing box cover.

4. Flooded suction adequate because large pipe connections minimize friction. KCAQ has 4″ suction, 3″ discharge on either side. KCA has 3″ suction, 3″ discharge on either side.

5. Less valve wear resulting from guided, wing-type valves that are self-grinding. Liberally-sized suction and discharge valves both removable through single top covers.

6. No shaft deflection problems. Extra heavy crankshaft has *all* roller bearings.

For complete information, get in touch with your nearby Worthington representative. Or write to Worthington Corporation, Section 32-4, Oil City, Pa. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

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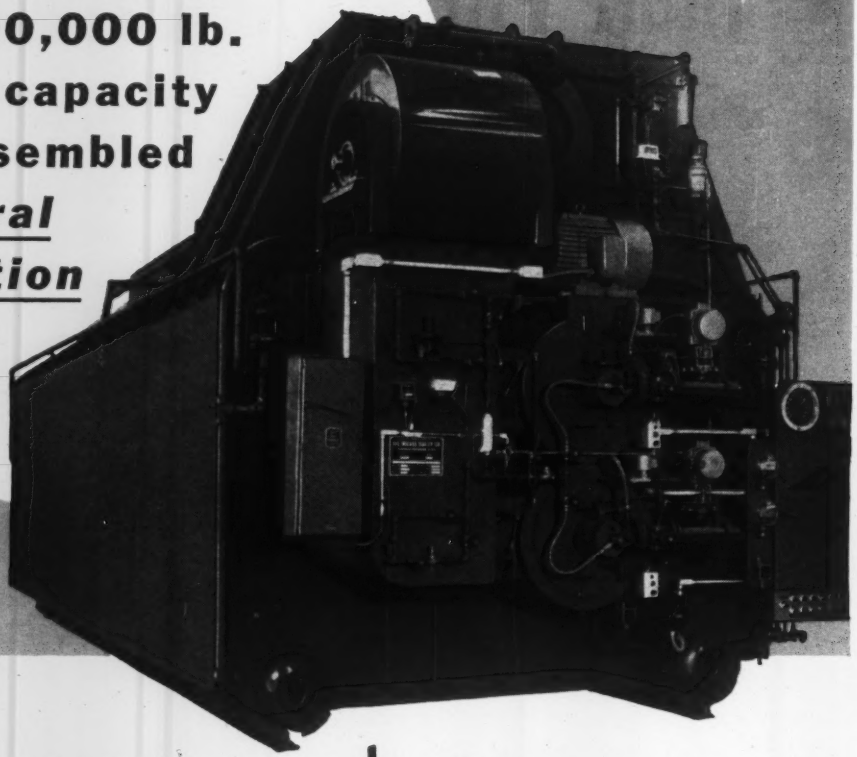
...now from WICKES

a new 100,000 lb. per hour capacity shop-assembled *natural circulation* boiler



Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be fired with oil, gas or combination of both.

All units are shipped completely shop-assembled including superheater, fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

Save on

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- Operating Expense
- Space
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For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

WICKES type A

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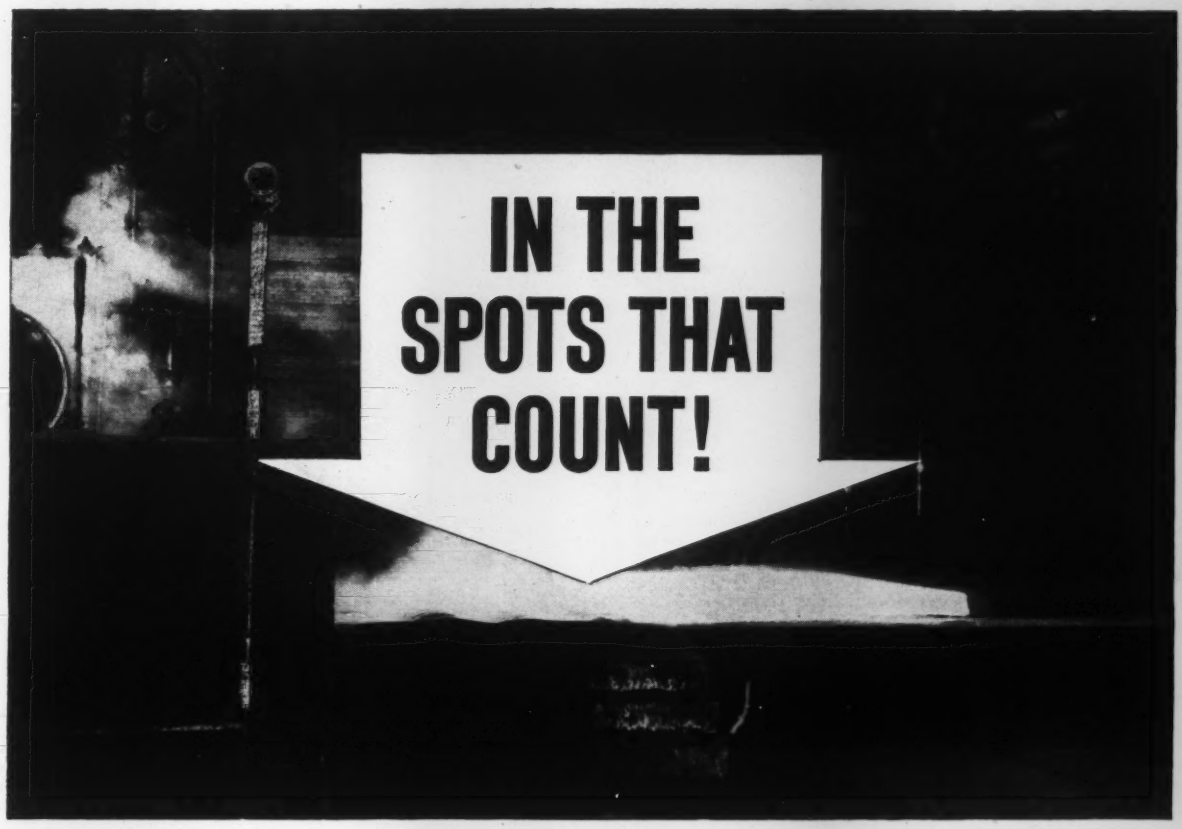
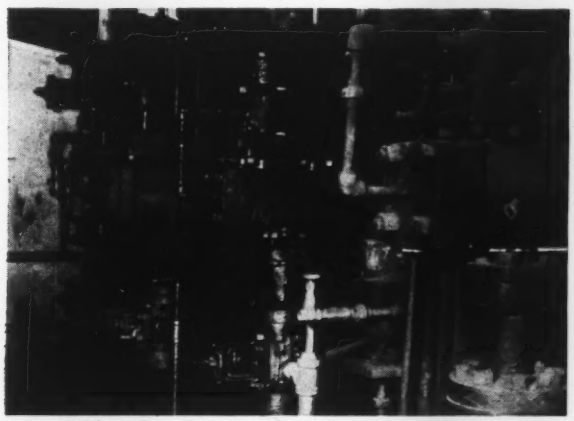


split-second control with Homestead® Operating Valves keeps steel plate rolling!



Solenoid-hydraulic pilot controlled 4" and 2½" Hydro-Cushion Homestead Operating Valves; and Lever-Seald Hydraulic Stop Valves; 800 pounds working pressure.

Six days a week, twenty-four hours a day, 250 times an hour, the tilt tables and middle roll of an East Coast Plate Mill are exactly positioned without shock, and held without creepage, by Homestead Operating Valves. This precision control has permitted record-breaking rolling of the hot steel slabs into plate.

Through more than *three and one-half million* split-second rollings during the two years the 2½" and 4" Hydro-Cushion Homestead Operating Valves have been in service, not one shutdown has been required for valve maintenance! Performance records such as these, are assured by the protected seat and cushioning action of the Homestead Valves.

For any hydraulic control problem, there is a Homestead Operating Valve to meet your needs. Send today for Reference Book 39-6.

38

Please send Reference Book 39-6 and prices on all types of Homestead Operating Valves.

Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

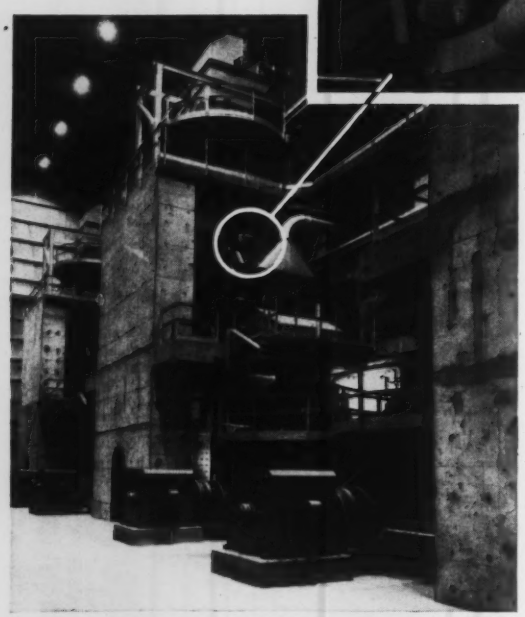
h v

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box 38, Coraopolis, Pennsylvania

Jeffrey feeders move coarse ore from surge bin to cone crushers. Balanced vibration assures quiet operation, definite control, low operating and maintenance costs.

Battery of Jeffrey feeders serves hungry taconite crushers

Jeffrey feeders at bottom of cone crusher move ore to next crushing stage.



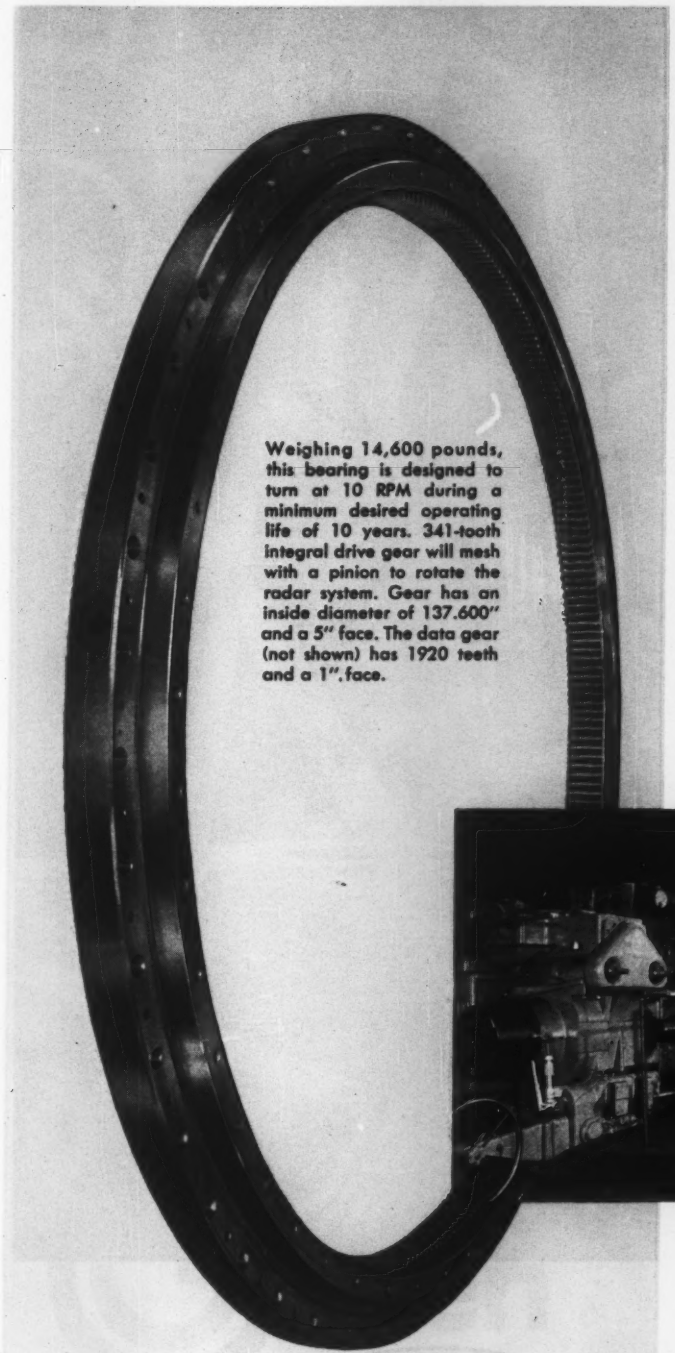
Into this stand of cone crushers passes a steady flow of coarse taconite ore, fed by a battery of 36 Jeffrey vibrating feeders. Fine ore is fed by Jeffrey vibrating feeders to screens ahead of the short head crushers.

Dependability of Jeffrey equipment helps move materials at a 24 hour-a-day, year 'round pace. *Efficiency* of Jeffrey equipment helps make the whole operation economical. Use Jeffrey experience on your materials handling problems. The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

Huge bearing for Nike-Zeus radar system incorporates Farrel® precision internal gears



Weighing 14,600 pounds, this bearing is designed to turn at 10 RPM during a minimum desired operating life of 10 years. 341-tooth integral drive gear will mesh with a pinion to rotate the radar system. Gear has an inside diameter of 137.600" and a 5" face. The data gear (not shown) has 1920 teeth and a 1". face.

The largest precision ball bearing ever fabricated—13'9" in diameter, with 88 four-inch balls—has recently been completed by the Kaydon Engineering Corp. Designed to carry a rotating dead weight of up to one million pounds, it will be used in the supporting pedestal of a Nike-Zeus radar system.

Drive and data gears were cut by Farrel to very close tolerances. These were made integral with the bearing to eliminate the accumulative errors inherent when a number of parts are pieced together, and to simplify the design.

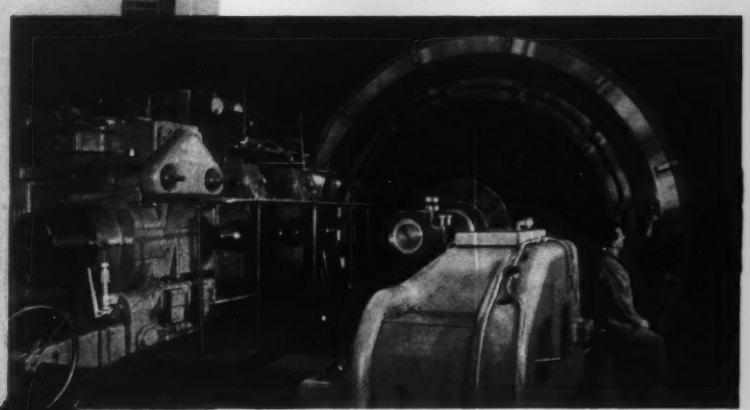
The Farrel generator on which the gears were cut combines the capacity to handle work of such proportions with the precision demanded for this application. Farrel internal gears are available with spur or single-helical teeth in sizes up to 23'0" external blank diameter, 20" face, ¾ DP.

Ask for details of large gears to meet your requirements.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia & Derby, Conn., Buffalo & Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Los Angeles, Salt Lake City, Tulsa, Houston, Atlanta
European Office: Piazza della Republica 32, Milano, Italy

FARREL

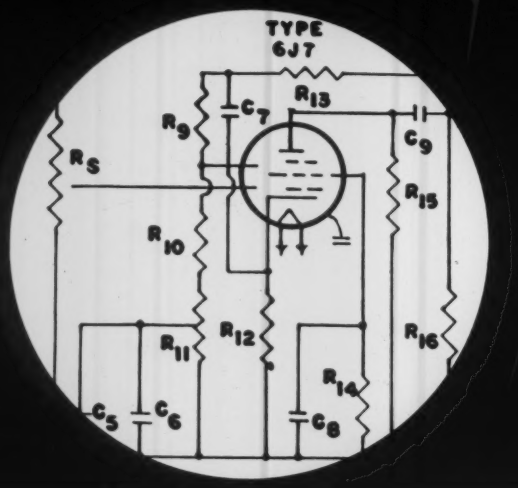


Generating a precision internal gear, similar to the one supplied to Kaydon in a Farrel gear generator.

FB-1172

CRONAFLEX®

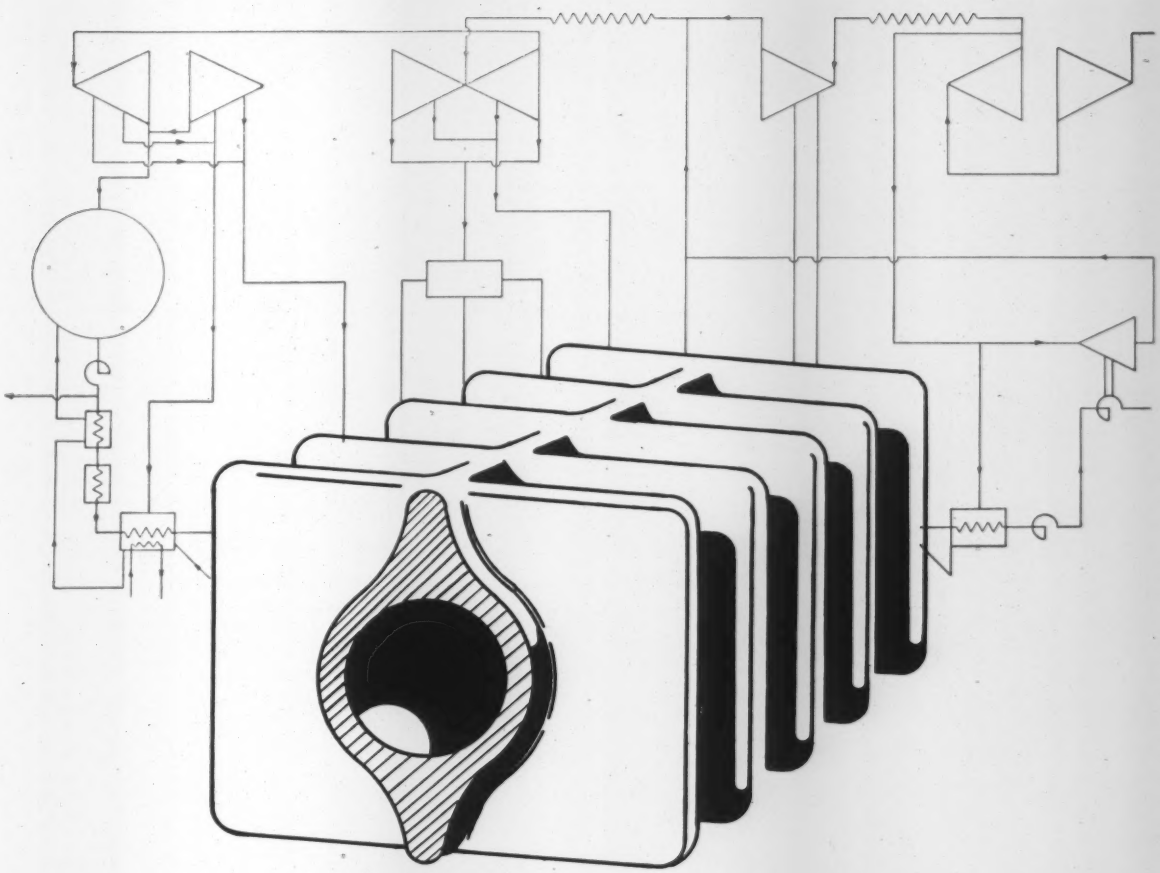
ENGINEERING REPRODUCTION FILM



...ANOTHER FINE TOOL OF FINE ENGINEERS

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*



Green's Low-Level Economizer belongs on your steam cycle flow diagram!

Why has Green's Low-Level Economizer already been purchased for inclusion in several large units scheduled for operation in 1960, 1961 and 1962?

1. It is accepted that low-level heat recovery offers the most economic method of obtaining the lower heat rates required today.

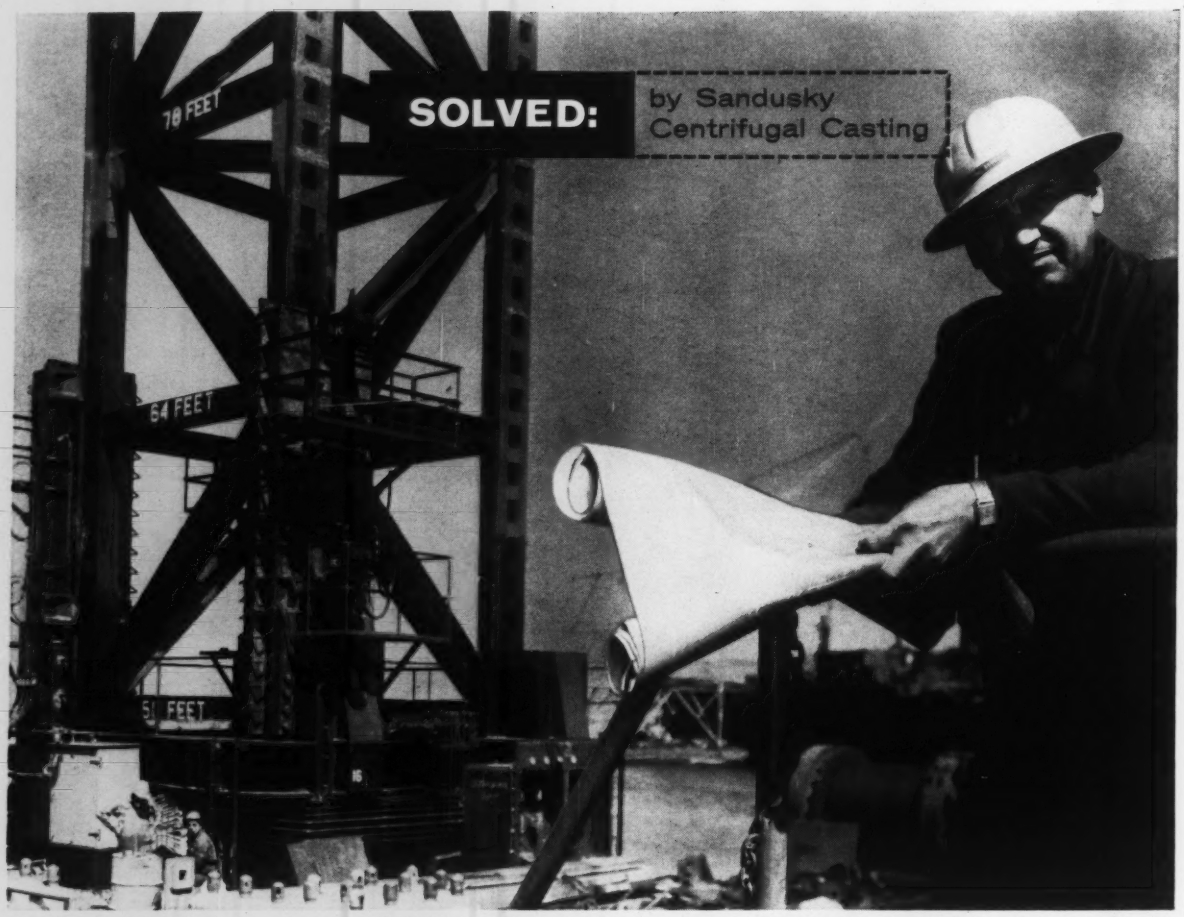
2. Flue gas-to-water heat exchange transfers the low temperatures from the airheater to the Low-Level Economizer where the problems of corrosion and plugging can be adequately resolved.

Green has had over 100 years of economizer experience. It is yours for the asking.

Green

THE GREEN FUEL ECONOMIZER CO., INC.

BEACON 3, NEW YORK



One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris*, to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186" lengths, machined to 24" O.D. with 2" thick walls and sectioned into four pieces 43" long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . . COST—saving about half the cost of an alternate method of manufacture . . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

When you need cylinders from 7" to 54" in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

5902

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

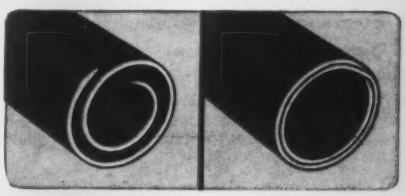
Bundy can mass-fabricate practically anything

...and we use Bundyweld®—the double-walled steel tubing—for parts that must meet rigid specifications

YOUR tubing headaches are Bundy's business. Our tubing engineers will work with you at any stage in the development of your product. With years of problem solving experience, we can often suggest short cuts that cut costs of tubing parts—or find practical solutions to tough bends.

Then we'll mass-fabricate these parts on machines specially designed by Bundy for precision bending. We use Bundyweld, the original double-walled steel tubing, that has become the safety standard in small-diameter tubing. It's thinner walled—yet stronger, has high bursting and fatigue strengths. Covered by Government Spec. MIL-T-3520, Type III.

Why don't *you* take advantage of Bundy's complete service: expert engineering help, mass-fabrication savings, *Bundyweld* tubing. For more information see Sweet's Product Design File, le/Bu . . . or contact us!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to 5/8" O.D.

There's no substitute for the original Bundyweld Tubing.

BUNDY® TUBING COMPANY

HOMETOWN, PA. • DETROIT 14, MICH. • WINCHESTER, KY.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

New... from MARSH!

MARSH
Master-mite
SOLENOID VALVES

Small solenoid valves that Fill a BIG order

Yes, a series of small, direct acting solenoid valves that fulfill today's critical requirements for rugged, positive-acting tight-seating valves in types, patterns, orifice sizes and electrical ratings for use on a particularly wide variety of media including air, water, petroleum products, coolant, oxygen, hydrogen and acetylene.

They are new only in the production sense. Actually this announcement was preceded by long development and research which drew on more than 90 years of experience in instrument and valve making.

The net result is a valve that combines instrument-precision with the ruggedness that distinguishes all Marsh Valve Specialties!

Despite their small size, "Master-mite" Solenoid Valves are more rugged because the "beef" is where it counts—in the valve body. The generous, moisture-resistant coils do not overheat. Entire assembly is leak-tight at pressures up to 540 psi. Operation is positive . . . yet quiet. Valves can be cleaned without breaking connections . . . can be used in any position.

Bodies are available in either brass bar stock or 18-8 stainless steel. All parts in contact with media are stainless steel. Down to the last detail, "Master-mite" solenoid valves are designed and built to stand up and work right under the toughest conditions including vibration. They are Underwriters' approved for use on oxygen and hydrogen and as safety valves.

Read the accompanying specifications. Note the wide range of selection. Ask for bulletin containing all details.

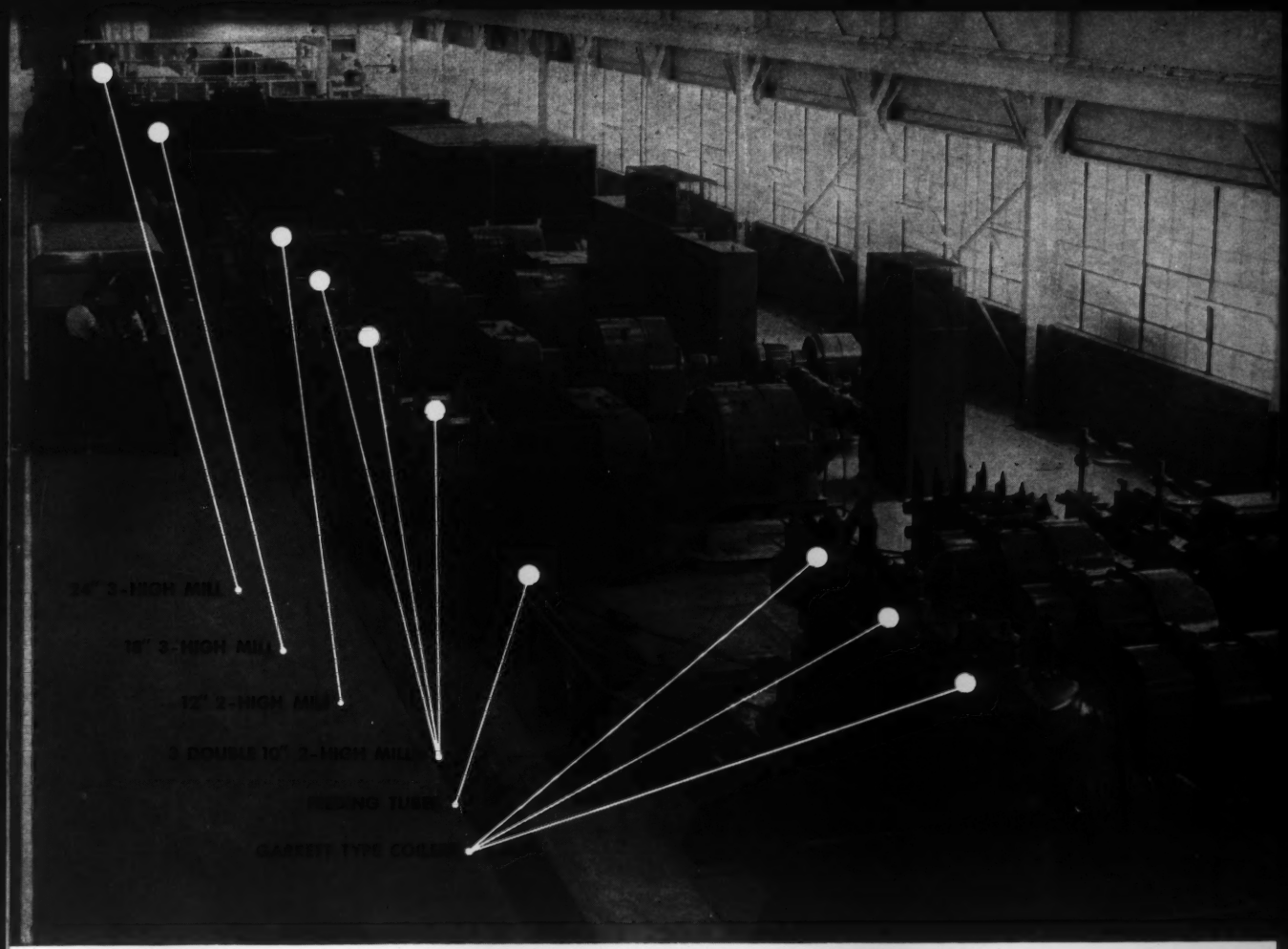
Note these specifications

★ **Types:**	Direct acting conduit type and grommet type. Four patterns of each size and type: globe, bottom outlet, angle left, and angle right.
★ **Sizes:**	⅛" and ¼" NPT.
★ **Pressures:**	From vacuum to 540 psi. maximum.
★ **Orifice sizes:**	Ten sizes: 3/64", 1/16", 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 1/4".
★ **Voltages:**	Standard with 115 volts 50/60 cycle AC coils, but also available in 12, 24, 208, 230 and 460V, 50/60 cycle coils.
★ **Leads:**	Standard with 18", but other lengths available; also full range of connectors.
★ **Body:**	Brass bar stock or 18-8 stainless steel.
★ **Moving parts:**	All stainless steel.
★ **Seat disc:**	Synthetic rubber.
★ **Approved by Underwriters' Laboratories as a safety valve.**	

New bulletin tells the whole story

Shows all types, patterns, sizes, coils, options, etc., and contains highly useful flow curves.

MARSH INSTRUMENT COMPANY
Dept. 29 Skokie, Illinois
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.



Modern continuous copper wire rod mill designed and built by Loewy-Hydropress.

LOEWY wire rod mills reduce wire bars to 5/16 in. wire rod automatically

This Loewy copper wire rod mill, which has been in successful operation for 2 years, rolls 5/16 in. wire rod from standard wire bars in a continuous operation. It is fully automated and all phases are controlled from one pulpit.

In addition to excellence of product, the owner is extremely pleased over the fact that, due to automatic operation, this installation permitted him to start operations with an inexperienced crew.

Whether you are a user or producer of wire rod, your competitive situation probably calls for equipment which functions flawlessly and with minimum personnel. Careful economic study might well reveal that the installation of a wire rod mill would be highly profitable for you.

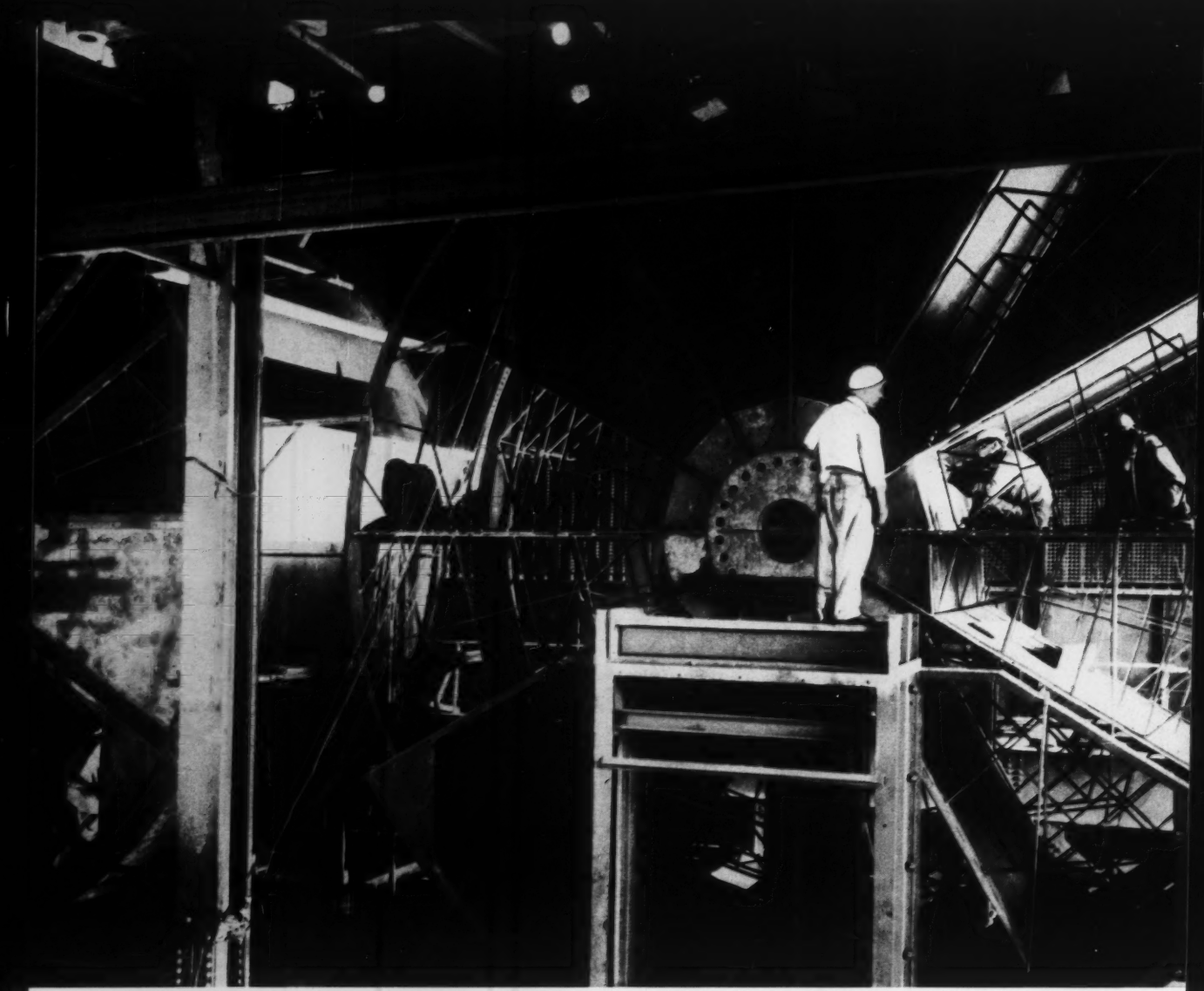
Consult us—without obligation—on a mill which will answer your individual requirements for wire rod. Write Dept. F-12.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON



Two of the four Ljungstrom Air Preheaters under construction at Potomac Electric Power Co.'s Dickerson Power Plant, Dickerson, Md. Each pair of these Ljungstroms, with a combined heat exchange surface of 475,000 sq. ft., will serve one boiler, evaporating 1,300,000 lbs of steam/hr. The first 175,000 KW unit was placed in operation in June this year and a duplicate unit is now under construction.

AIR PREHEATER SERVICE
PROTECTS POTOMAC ELECTRIC POWER CO.'s NEW **LJUNGSTROMS®** TWO WAYS

From the moment they start—and for as long as they operate—these Ljungstroms will get double-header Air Preheater service: protection against routine wear, and insurance of maximum operating efficiency. This is how.

Lifetime Air Preheater Service provides regular inspection and the services of expert technicians throughout the life of each unit. Air Preheater engineers make personal calls at least once a year on every Ljungstrom installation to make sure that all units are in top condition. This type of service is still in effect on Air Preheaters dating from 1923.

Rapid factory service gives the best possible protection against routine wear, the best insurance of readily-available replacement parts. In one typical case, an Air Preheater customer 500 miles from the factory received *custom-fabricated* parts within ten hours after his initial request for these parts.

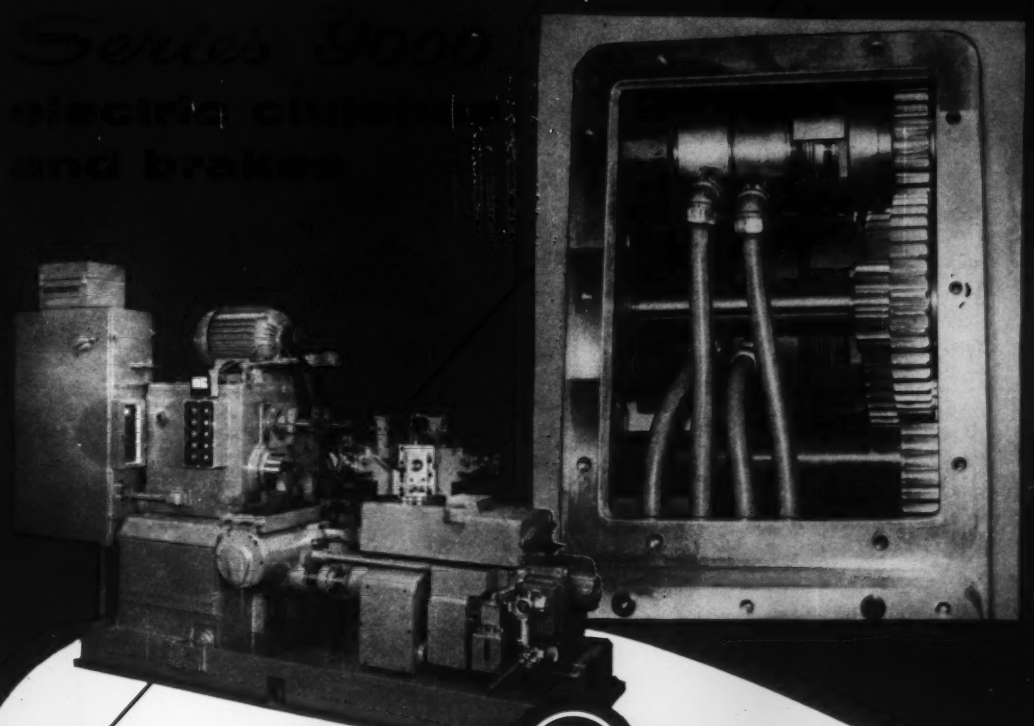
Regular inspection and fast response to emergencies are just two advantages Air Preheater offers its customers. Another is expert knowledge of boiler and preheater problems, gained through 35 years' experience. These reasons—knowledge of our customers' problems and a *continuing* interest in them—probably explain why nine out of ten preheaters sold today are Ljungstroms.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

Maxitorq

Series 9000
electric clutches
and brakes



an outstanding design feature of tape-controlled automatic turret lathes

Five Maxitorq Series 9000 Electric Clutches are used in the all-new Potter & Johnston No. 3E-15 Tape-Controlled Automatic Turret Lathe. Four are used in the headstock to provide automatic spindle speed changes and a fifth is used as a master clutch in the feed drive. These clutches of advanced design have PROVED their ability to assure consistent, positive and extremely fast action; essential to these machines. They transmit full load, are self-compensating for wear and permit great flexibility in control.

With operation induced entirely by magnetic flux, Maxitorq Series 9000 Electric Clutches are well adapted to a wide range of machine tool drives. They are simple and rugged in design, require no adjustments, can be used *either as a clutch or brake* and are built to American Machine Tool Standards. Disc separators not only separate discs, providing a drag-free neutral without heating, but also break up residual magnetism and permit extremely fast, positive action.

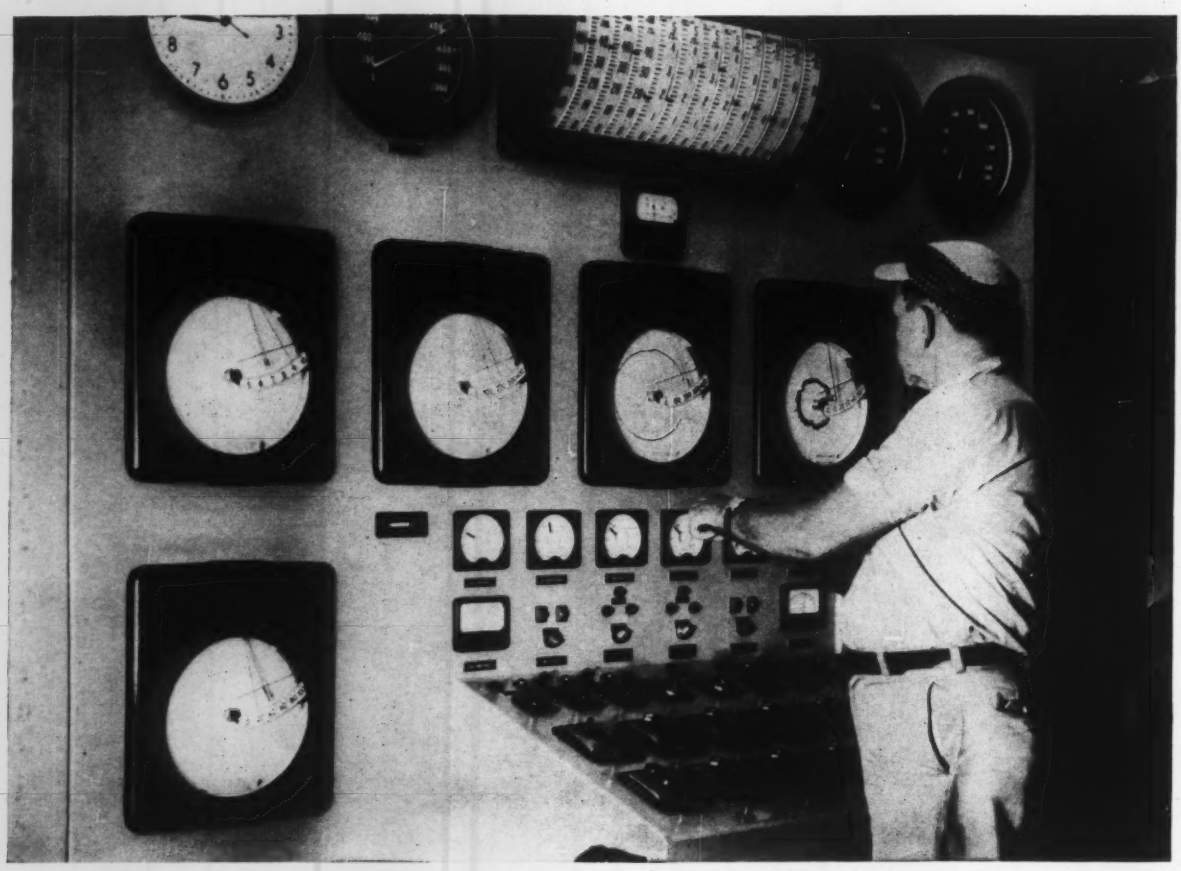
The 9000 Series Clutches have a minimum of moving parts and the electrical operating unit remains stationary, hence, there are no brushes, slip rings or complex wiring. Maxitorq Clutches operate on 110 V. A. C. rectified to 90 V. D. C. Other voltages on special order.

If you have a clutch or brake application where you are looking for new and improved performance, bring your problem to us.

Phone, wire or write Dept. ME for Series 9000 Bulletin.

The Carlyle Johnson Machine Company, Manchester, Conn.

3CJ59



Control Room for Cyclone Furnace Boiler at Mathews No. 2 Power Plant of Greenwood Mills, Greenwood, S. C. Bailey MINI-LINE System concentrates controls at operator's station.

How BAILEY simplifies operation of STEAM PLANTS

Your operators can work more efficiently, make adjustments faster when you put Bailey Controls at their finger tips.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report.

Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs.

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment, that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant problems.

A138-1

Instruments and controls for power and process

BAILEY METER COMPANY

1026 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

THE PROPER WIND IN SPIRAL-WOUND

It's the precise control of gasket densities for every stage in the pressure series that makes each Flexitallic Gasket right for a given flange.

Flexitallic Spiral-Wound Gaskets are engineered to meet extreme conditions encountered in keeping with the pressure/temperature rating for the specified assembly.

These controls mean that a Flexitallic Gasket, designed for an extreme pressure/temperature rating, is never so soft that it crushes under the specified load, and never so hard that it resists the compression necessary for a specified seal.

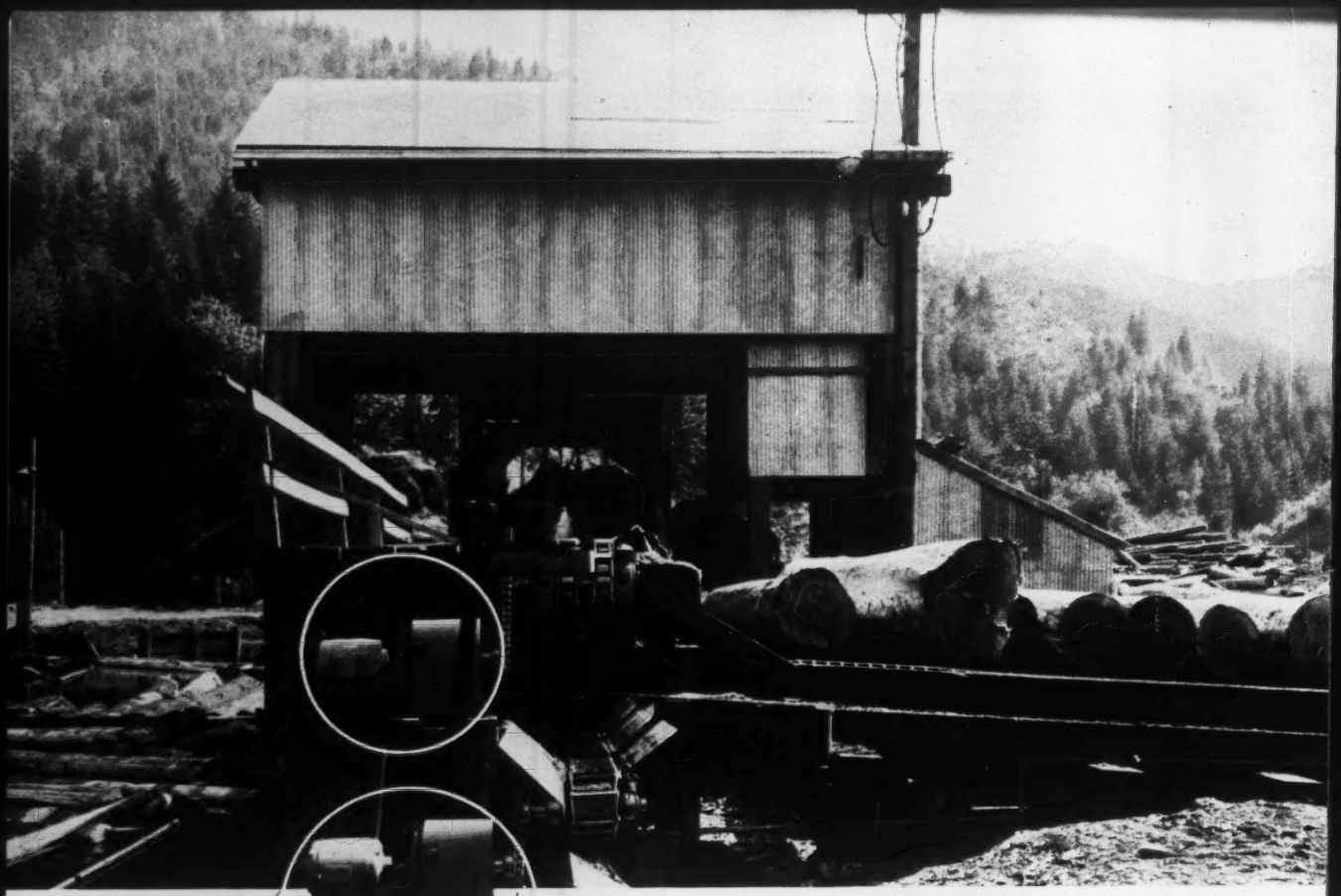
For predictable performance throughout all pressure/temperature ratings, look for Flexitallic Blue, the blue dye in the Canadian asbestos filler. It identifies the original Spiral-Wound Gasket construction.

FLEXITALLIC GASKET CO.
8th & Bailey Sts. Camden 2, N.J.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

* Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.



FALK Motoreducers driving log conveyor and refuse conveyor at the modern mill of The Bohemia Lumber Company, Culp Creek, Oregon.

FALK *all-steel* Motoreducers give you longer service life

Whether your load conditions are normal or heavy, the extra rigidity of all-steel construction (more than twice that of cast iron) maintains better alignment of revolving elements under load...a vital factor in prolonging the service life of gears and bearings.

And if your installations are subject to shock loads, or accidental external impacts, you're way ahead when you install Falk All-Steel Motoreducers. These rugged units do not destroy themselves by tearing off their feet under jamming overloads, nor are their housings subject to cracks which both dissipate the vital lubricant supply and allow revolving elements to get out of alignment.

All-steel construction is one of the built-in extras that you get in Falk Motoreducers. Others include: (1) 12 to 15% reserve load-carrying capacity in the gears (by AGMA standards), thanks to exclusive Falk extra-depth, high pressure angle helical gears; (2) maximum mechanical efficiency (98½% per gear mesh, under full load); (3) your choice of standard units (horizontal, vertical or right angle) to fit your precise requirements.

HORSEPOWER RANGE: to 75 hp . . . STANDARD OUTPUT SPEEDS: 780 rpm (high) to 1.2 rpm (low).

Prompt delivery from distributor stocks, or from warehouse or factory. Ask your Falk Representative or Authorized Falk Distributor for ***Bulletin 3100.***

THE FALK CORPORATION, MILWAUKEE 1, WIS.

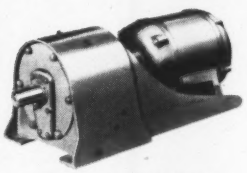
MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

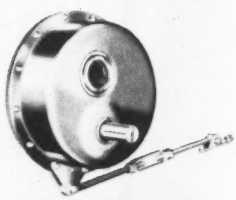
FALK

...a good name in industry

Take your choice of all-steel drives when you specify Falk



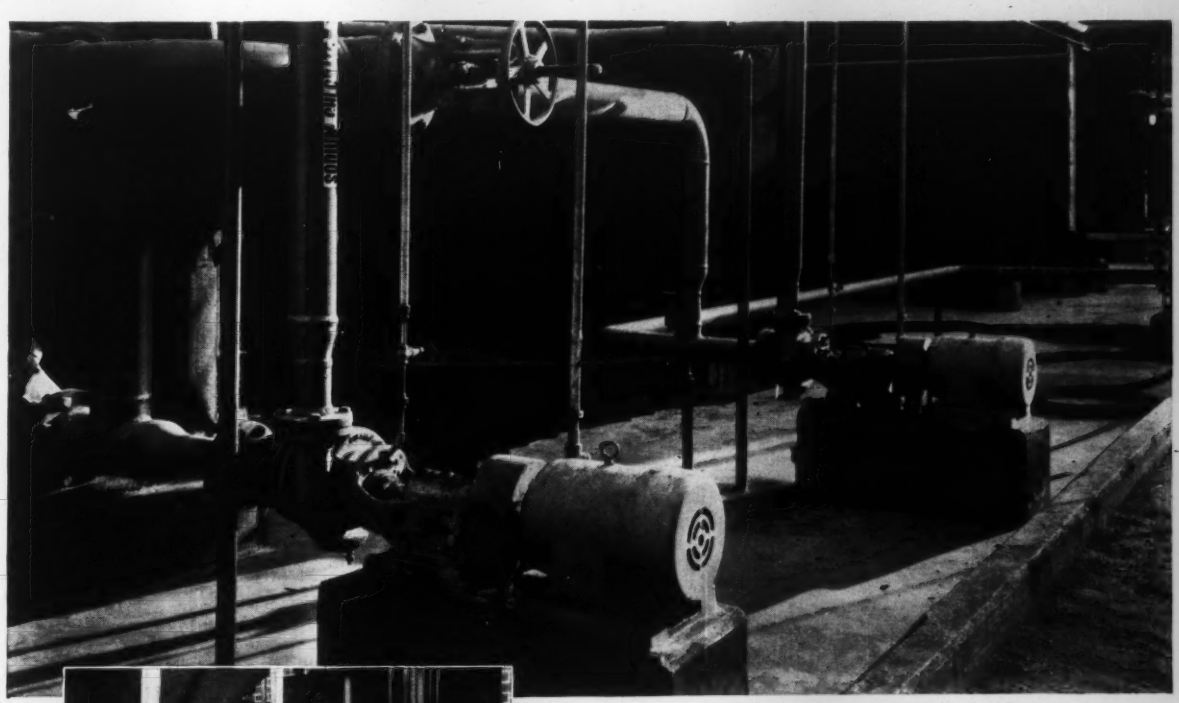
THE FALK ALL-MOTOR MOTOREDUCER
...the original All-Motor unit

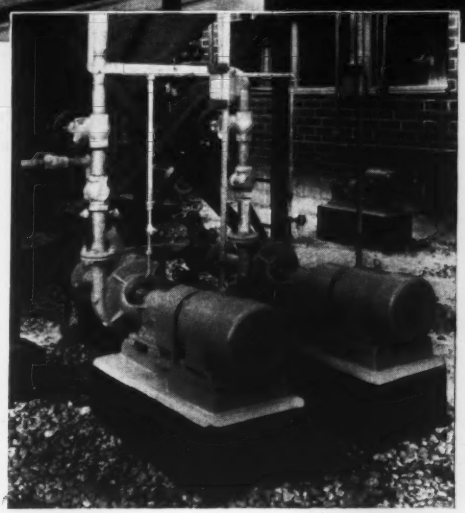


THE ALL-STEEL FALK SHAFT MOUNTED DRIVE

Torque ratings to 41,000 lb-in at low speed shaft. Also available in flange-mount design.

FALK and ALL-MOTOR are Registered Trademarks.





Above — "Buffalo" Single Suction Full Ball Bearing Pumps, stainless steel construction, handling sodium chlorate.

CORROSION— CONTAMINATION CONTROLLED WITH "BUFFALO" PUMPS

At left — "Buffalo" Single Suction Pumps of stainless steel construction handling hydrogen peroxide bleach.

Using a wide range of materials of construction, "Buffalo" offers a line of pumps capable of handling your toughest liquid moving job. You can order a "Buffalo" pump made of Hastelloy B or C, nickel, bronze, lead, stainless, in fact just about any material that can be cast and machined.

Properly applied, these pumps can cut your liquid moving costs, reduce down-time due to pump failure and improve quality control where contamination may be a factor.

For your tough liquid moving jobs, phone or write your "Buffalo" Engineering Representative or write direct. Tell us the liquid you want to pump and we will be pleased to suggest the best material of construction for the job.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION OF BUFFALO FORGE CO.

148 Mortimer Street Buffalo, N.Y.

Canada Pumps Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

One of a series

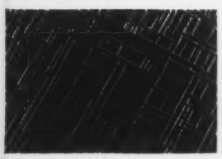
The revealing face of an iron crystal

A single crystal is an ideal system for studying the solid state. Physicists at the General Motors Research Laboratories have turned to whisker-like growths of nearly perfect single iron crystals to investigate three intriguing phenomena: magnetic domains, dislocation defects, and—more recently—high temperature oxidation.

In this latest study, the two crystallographically different surfaces found on iron whiskers are being used to examine the anisotropy or axial-dependent nature of the oxidation process. In early stages of oxidation, the oxide patterns that form on clean surfaces have been found to be strongly dependent upon the orientation of the underlying crystal. In later stages of oxidation, tiny oxide "cilia" actually grow on the surface of the iron whisker. But these new whiskery forms of oxidation are no longer related to the crystal's surface arrangement. The next step in this program involves correlating the oxidation behavior with lattice structure defects such as vacancies and dislocations.

This type of solid state research is revealing the atomic processes underlying strength, magnetic characteristics, and corrosion resistance of metals. At GM Research, we believe the solution to practical problems is increasingly dependent on fundamental information such as this. And each solution enables us to continue to provide "More and better things for more people."

GENERAL MOTORS RESEARCH LABORATORIES



Early Oxidation
(750x)

Oxide Whiskers
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Reduction of Oxide Products
(2500x)

MECHANICAL ENGINEERING

VOLUME 81 • NUMBER 12 • DECEMBER, 1959

Cooper Union's Century

When The Cooper Union was founded on Nov. 2, 1859, it was the nation's first experiment in private support of free education. Today, as The Cooper Union embarks on its centennial observance, which will continue through the academic year of 1959-1960, it still offers college instruction free of tuition charge and has expanded its accredited courses in science, engineering, architecture, and design. The undergraduate enrollment, numbering about 1300 young men and women, is still selected for intellectual ability alone, without regard for race, creed, sex, or economic status. (See photo story in "Roundup.")

That Cooper Union is a unique institution may be ascribed to the fact that founder Peter Cooper was himself a unique person—unique in that he donated a large part of his fortune to the public good during his lifetime. Starting as a poor boy with no formal education, he became an inventor whose many creations ranged from a self-rocking cradle, which was successful, to a flying machine which was unsuccessful. He built America's first locomotive, "Tom Thumb," for the Baltimore and Ohio Railroad; was sponsor with Cyrus Field of the laying of the Atlantic Cable; and made a fortune from the manufacture of glue and iron.

It was at the time of his first job, as an apprentice coachmaker, that he dreamed of building a "spacious, handsome, and enduring edifice" for a free school to "improve and elevate the working classes of the City of New York."

On Nov. 2, 1859, Peter Cooper's dream became a reality. Thousands attended the dedication of the school and were amazed at what they saw. For example, the auditorium was in the basement. Cooper, ingenious man that he was, put it there as a safety measure. Reason: In case of panic, he felt fewer would be injured escaping upstairs. Another innovation: A big fan circulated air through vents under the seats—air conditioning 100 years ago.

Because it was the largest meeting room in New York, seating more than 2000 then but 1500 now, it became known as the Great Hall. Lincoln made his historic "Right Makes Might" speech there in 1860. Mark Twain's first lecture in the East was given in the Great Hall. From the day it was opened it has been a symbol of liberty, of free speech, and free assembly.

A century ago when a college education was for the few, Cooper Union offered a modest education for the many. Today with more than 3,000,000 Americans in colleges, Cooper Union's role has changed to that of giving the best possible professional education without cost to the selected few who prove themselves best able to use it.

In a recent study, "The Younger American Scholar: His Collegiate Origins," by Robert H. Knapp and Joseph J. Greenbaum, Cooper Union's School of Engineering emerged as one of the "Big Three" technical schools in the nation in the production of scholars. Only the California Institute of Technology and the Massachusetts Institute of Technology produced a higher proportion of PhD's and fellowship winners.

Cooper Union also is unique in that it offers educational facilities free to the general public. These include its museum, library, and adult education program. From 60,000 to 70,000 persons attend the adult courses annually.

Its plant includes a second building, the Hewitt Memorial Building. A third building, under construction, will be used by the School of Engineering.

Thus, after a century of teaching those who will learn, Peter Cooper's experiment in free private education can surely be called an unequivocal success.

J. J. Jaklitsch, Jr.

Editor, J. J. JAKLITSCH, JR.

OBLIGATIONS

A colleague of mine has stated that a professional man is one with a special body of knowledge and understanding toward which he feels three compulsions: To use it in the public interest, to add to it by his own efforts, and to teach this knowledge and this understanding to his contemporaries and to the coming generation.

These are the characteristics that have always set the professional man off from the businessman, the tradesman, and the worker. Society will not long withhold its recognition of our profession when the majority of engineers live up to these compulsions. We have the obligation to do so.

Active participation in all phases of a professional engineering society's activities, such as ASME, is one of the most effective means the individual engineer has of implementing his obligation and realizing his opportunities.

The World Explosion

This is the most explosive age in all history. Whether we consider population growth in the world or in this country, industrial expansion, income per capita, medical and scientific progress, education, books and magazines published, energy and electric power used, speed in miles per hour, or distance in space probed: Whether we consider the seething political unrest and longing for a better life, and health, on the part of the world's underprivileged billions—in each of these areas there are great obligations and opportunities for the engineer.

On the military front, without scientific and engineering supremacy, we haven't a chance of surviving, except at the price of ignominious surrender. I believe we now have scientific and engineering leadership, and that we can maintain it as we have in the past, if we each realize that this is the situation—that in the vernacular of the day, "this is it"—and do something about the matter. When it comes to the real business of defense, the engineer is today in the front line as never before in this world's history.

In this conflict all our instincts, desires, and prayers are for a peaceful world in which we can turn our talents, training, and experience toward making this world a better place for men of all nations to dwell. But if the future holds a continuation of the struggle for existence and the survival of the fittest on a national scale, the engineer's obligation is clear, to exert the utmost effort to see that the forces of freedom and the civilization of the West are enduring . . . and rest assured that, unless the diplomats and statesmen can avert the conflict, the results will depend upon the success of our contest in the field of science and engineering.

Tomorrow's Engineers

An obvious imperative is to give more attention to the excellence and adequacy of our children's and our grandchildren's education, not only along scientific, but cultural, economic, and sociological lines as well. We need to see that these youngsters are all challenged to the limit of their ability, but particularly we should see that those with talent—children of whom much is to be expected—are encouraged and challenged to the limit of their capacity.

We engineers should know that the current problem of insufficient teachers, insufficiently trained teachers, and underpaid teachers, can only be solved by the same engineering techniques by which these same problems have been solved in the factory, on the farm, in the mine, in the oil field; namely, by giving the workers—in this case, the teachers—better tools so as to increase their effectiveness. This means more modern buildings, better books, effective and adequate educational TV, and educational movies whereby whole courses are taken over by these modern aids, but with the teacher's help, co-operation, and leadership. We know these techniques have worked before. They can be made to work here. We engineers can help.

We shall need innovation, which depends on creative ideas. We always have more creative ideas than we use; many—in fact the majority—should not be used. Critical discussions, and trial with resultant success or failure, are the means we use to separate the good and useful from the unfit creative ideas. Still, new ideas are tender things when first hatched and easily killed or set back for years by rough handling, or by unsympathetic, critical, or antagonistic reception.

In my own field, I was shocked to hear a young associate of mine say that we were not applying as many new things as he hoped we would because of the NIH

Based on an address presented at the President's Luncheon at the Semi-Annual Meeting, St. Louis, Mo., June 14–18, 1959, of The American Society of Mechanical Engineers.

If we can't see beyond our profession, the profession suffers. Here are excerpts from President Warren's address at the Society's Semi-Annual Meeting, a directive to engineers to broaden both their thinking and their active participation in public affairs.

By Glenn B. Warren

OF AN ENGINEER

President, The American Society of Mechanical Engineers

factor. This was new to me, but he explained it meant the "'Not Invented Here" factor. One might consider this merely amusing, but if he is right, it could be serious.

From talking to engineers and scientists who have recently returned from visits to Russia, from information services, and from several recently made translations of Russian papers and articles, I have found that the Russians have adopted as general practice—and at least three years ahead of us—six specifically improved techniques which we have known about, but which we have not applied to practice until just recently, or not at all. It is as though someone in authority in Russia has commanded them to go out through all the world and seek out the best practice in every field, and then to come back and apply this best practice now, and to everything they do. In the meantime, we protest that we are doing things well enough without adding the complication of these new refinements and improvements.

Cost of Production

We are being challenged in another area as never before, that is, regarding the cost of production. Lowering costs of production has been one of the engineer's principal goals for 200 years, first as to design, then as to manufacture, finally as to use. Inflationary forces are tending to nullify his work here, and extra effort will be necessary to meet this challenge.

Ralph Cordiner, before the Senate Antitrust and Monopoly Subcommittee of the Senate Judiciary Committee, recently suggested that the law which now requires the Federal Government to shape its policies toward measures which give full employment, should be amended to also make it the Federal Government's responsibility to preserve the purchasing power of the dollar. This, in my judgment, every engineer should endorse and urge action toward, because inflation, if not stopped, will defeat most of the things we engineers have been working toward for the past 150 years.

Up to now we have been discussing our obligations and opportunities as working professional men. We have another complete facet of our existence as citizens, wherein our talents, our training, and our experience should make us particularly effective in this whole battle for the survival of freedom. We should be able to see many things clearer than most people who do not have this background.

The whole world wants a better life—a higher standard of living—better hospitals, schools, homes, roads, health, and so on. Everything in the background and experience of an engineer teaches him that these things can only come from increased production, full employment, the adoption of efficient methods, the elimination of featherbedding, the use of new and improved power-driven tools and processes. In this the engineer has made and will make continuing contributions.

Foreign Aid

Foreign Aid is a matter which is under public discussion today with much misunderstanding. The undeveloped countries should be shown that their acceptance of and fair treatment of foreign investment is not exploitation if properly applied, but in reality simply the loaning of badly needed production tools for which a proper rental must be paid. By friendly, sympathetic, understanding support and guidance of a continuing Government and private investment program much can be done. Being our "brother's keeper" here will probably help us to keep a peaceful and productive future.

One of the most unsettling problems in our economy is the annual uncertainties and confusion from recurrent labor-management disputes. In this connection, Owen D. Young, a former Chairman of the Board of General Electric, commented, in 1946, that organized labor was still fighting, with the weapons of 50 years ago, the war that they had won ten years previously. The thoughtful engineer must understand that all of production must go to meet our consumption needs, plus our requirements for defense; for capital goods; and for balance of foreign trade; and that with an increase in our production which better methods, tools, and effort will make, we can and must have a corresponding increase in real purchasing power from wages and salaries if our economy is to continue to function. This must come about through either increased wages and salaries, or lower prices. The engineer should also favor and advocate those measures which will minimize the periodic recessions with their forever-lost production.

An engineer should have a skill in meeting the needs of today, an understanding which will permit him to have an influential voice in the problems of today. His many talents make it obligatory that he try to use them in meeting these problems.

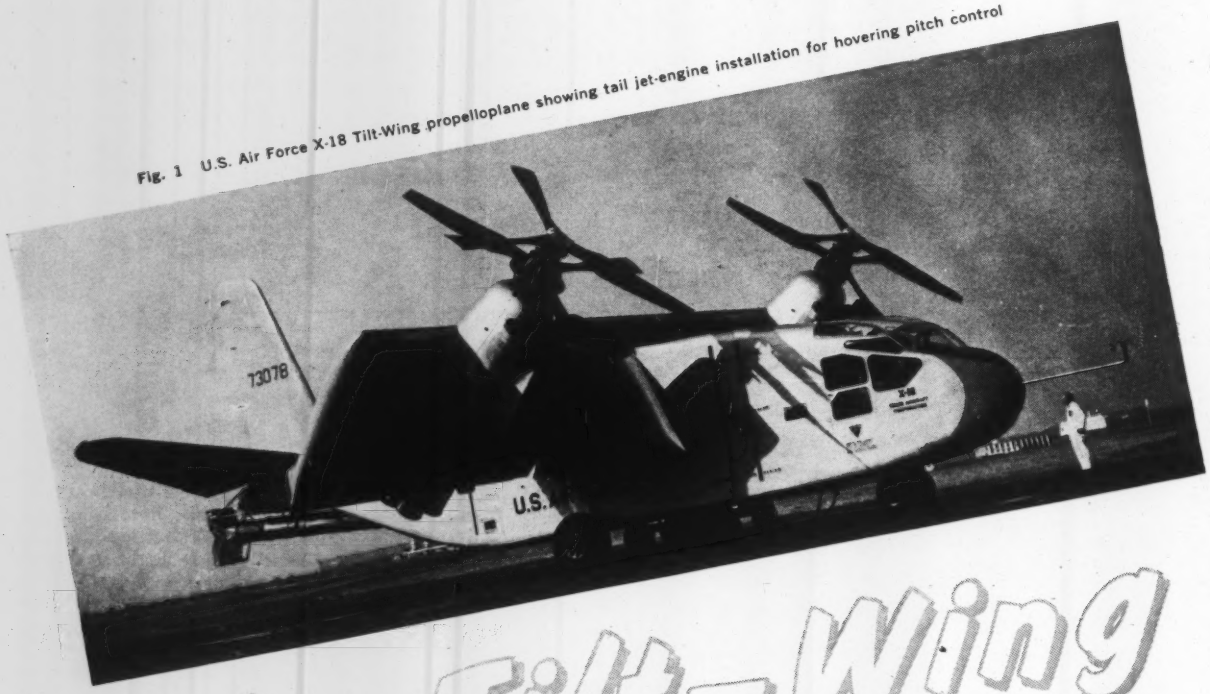

Fig. 1 U.S. Air Force X-18 Tilt-Wing propelloplane showing tail jet-engine installation for hovering pitch control

The Tilt-Wing

By J. B. Nichols, Mem. ASME, Manager, Advanced Planning Department, Hiller Aircraft Corporation, Palo Alto, Calif.

SINCE Korea, the military services alone have financed some 20 or more test beds of widely differing VTOL-type aircraft, and many more types have been proposed. There are two reasons for this feverish activity in the VTOL field. Recent developments in gas turbines have led to amazing weight reductions making previously impractical machines feasible. Furthermore, there is a very broad gap in the transportation spectrum between the operations which can be performed by a helicopter and those which can be performed by an airplane. It is this gap which the VTOL's are being designed to fill.

Nothing in the foreseeable future will replace the low-disk-loaded helicopter rotor for missions requiring extensive hovering or extensive periods of very slow flight. On the other hand, it is not reasonable to predict speeds for pure helicopters in excess of 200 mph. Only a few now attain 150 knots and very few have a steady-cruise speed as high as 100 knots.

The economics of vertical take-off can never be justified if space is available for a running take-off. With higher concentrations of population and increased speeds of commercial aircraft, the shorter-haul types must be improved if adequate benefit is to be obtained from the jet-transport era. Since military forces often fight in wholly unprepared areas and depend upon air transportation, vertical or short take-off is a necessity.

Which VTOL or STOL Types?

For economic reasons, few of the present scores of VTOL and STOL aircraft now in the design or test-bed stage will survive. Four years ago, the tilt-wing propelloplane, Fig. 1, was selected at Hiller as the most

Contributed by the Aviation Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 14–18, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 59—SA-35, originally entitled: "Product Analysis of Tilt-Wing-Propelloplane-Type VTOL Aircraft."

Inevitably, there will be a vertical-take-off plane, filling the gap between helicopter and airplane. One possibility is the "tilt-wing."

Propelloplane

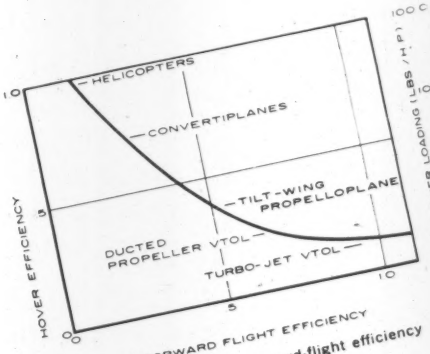

Fig. 2 Hover and forward-flight efficiency of various VTOL aircraft

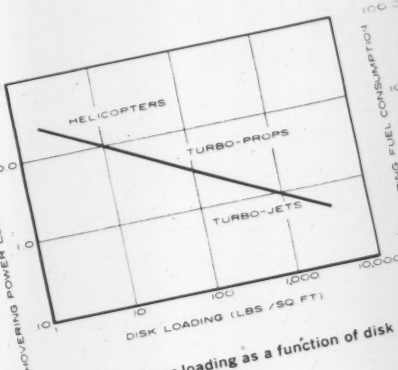

Fig. 3 Power loading as a function of disk loading in hovering

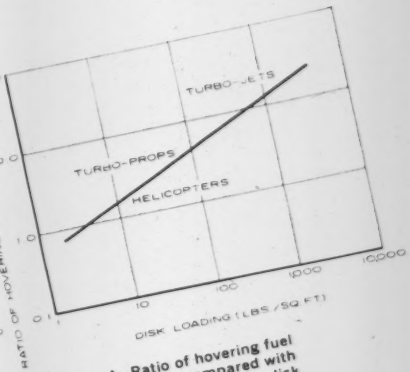

Fig. 4 Ratio of hovering fuel consumption (compared with fuel consumption for disk loading = 4)

promising of all VTOL types for the next step beyond the helicopter. The company is now even more certain that the great majority of other types will ultimately fall by the wayside.

The various types of VTOL aircraft are plotted on a hovering-efficiency versus forward-flight-efficiency basis, Fig. 2. The lower-disk-loading types offer higher forward-flight efficiencies and speeds. The tilt-wing propelloplane lies in the mid-zone of this spectrum providing a forward-flight efficiency greater than the helicopter and convertiplanes employing helicopter rotors in one form or another, and providing higher hovering efficiencies than the turbojet types of VTOL's. There are undoubtedly uses for all of the types shown. The propelloplane was chosen by Hiller to attain the design which promised to have the broadest area of uses, and therefore the greatest probability of a large market. An investigation of the various factors involved may help to show why the choice is believed to be sound.

First, examine the effect of disk loading. The rapid decrease in the number of pounds that can be lifted per installed horsepower as the disk loading increases from that of helicopters to that of turbojets is shown in Fig. 3.

This decrease of power loading with increasing disk loading has a direct effect on the hovering fuel consumption, Fig. 4.

The power-loading and fuel-consumption factors, when combined with the equipment weight involved, yield a combined lifting-system-plus-hovering fuel weight required as a function of the hovering duration required in any particular mission. The propelloplane is superior to the helicopter for hovering durations up to about 1/4 hr, while turbojet types of VTOL aircraft are competitive for hovering durations of only 2 or 3 min, Fig. 5. A 3-min hovering capability is unsatisfactory if the pilot has to "feel" for his landing space in bad weather.

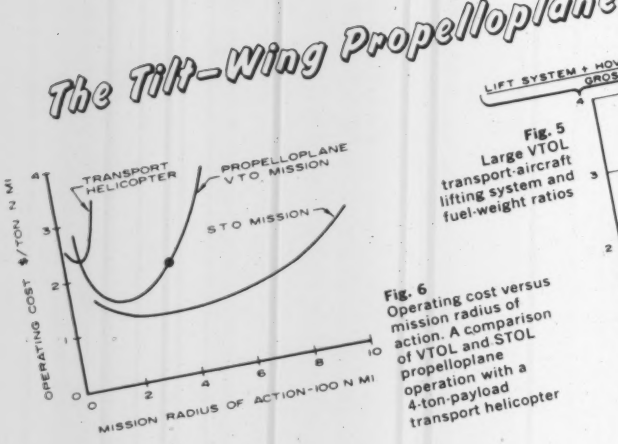

Fig. 6 Operating cost versus mission radius of action. A comparison of VTOL and STOL propelloplane operation with a 4-ton-payload transport helicopter

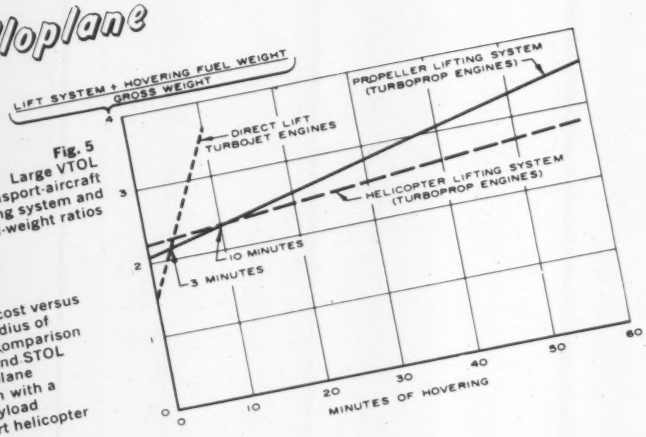
LIFT SYSTEM + HOVERING FUEL WEIGHT / GROSS WEIGHT
PROPELLER LIFTING SYSTEM (TURBOPROP ENGINES)
DIRECT LIFT TURBOJET ENGINES
HELICOPTER LIFTING SYSTEM (TURBOPROP ENGINES)
10 MINUTES
3 MINUTES
MINUTES OF HOVERING

Fig. 5 Large VTOL transport-aircraft lifting system and fuel-weight ratios

In spite of the importance of vertical or short take-off requirements, the primary purpose of most aircraft is some form of transportation. The operating cost in forward flight of propelloplanes is compared with helicopters in Fig. 6. These are military costs and are not applicable to civil operation. However, the relative costs are pertinent. Above 50 miles, the propelloplane has lower operating costs than the helicopter. In an airplane-type take-off the propelloplane has a major advantage. It can be overloaded to provide considerably higher payloads which are directly reflected in reduced operating costs.

The downwash velocity of aircraft, as a function of their disk loading, is already a problem because of ground erosion and dust raising. Although this problem will be even more severe with propelloplanes, these have considerably better downwash characteristics than the high-velocity turbojet exhaust, which also has a high temperature. These characteristics would require specially prepared areas for handling turbojet-type VTOL aircraft, defeating one of their primary advantages.

The remaining problem was to decide whether to choose the tilt-wing type or the deflected-slipstream type in which the wing remains stationary but a multiplicity of large flaps is employed to deflect the slipstream downward.

The deflected-slipstream type generates a high pitch-down moment which must be overcome by high downward tail loads, Fig. 7. These add to the lift force required from the main lifting system and, as a result, a double loss is incurred. Large flaps also subtract from the structural integrity of the wing. In the tilt-wing machine the wing can be designed as a continuous structure from tip to tip. No flaps are required, and the structural integrity of the wing is insured in a minimum-weight design. In fact, as a result of the good distribution of the power-plant weight in the propelloplane and because of the relatively short spans, the wing assembly, including the tilting mechanism, is actually lighter than the weight of conventional airplane wings, Fig. 8.

VTOL Versus STOL

One area which has not been touched upon is the VTOL versus STOL controversy. Actually there is no controversy over this point. If a mission requires vertical take-off, short take-off will not do the job, and it does not make sense to pay the price of a vertical take-off where a short take-off is acceptable. However, since a VTOL can take off with a forward run with a higher payload than when taking off vertically, it then becomes an STOL of sorts and competitive with pure STOL's. In fact, if runway length is of no concern, the only limit on the VTOL's payload capacity is its structural one.

The STOL is based upon the idea that the VTOL costs too much in installed power-plant weight and in reduced payload. If installed power can be markedly decreased by employing a short take-off run, say 500 ft, then it is well worth while. Further, the preparation required for the short landing and take-off area can be tolerated, even in most wartime missions. With this in mind, the STOL is designed around some arbitrary short take-off distance. With such an extremely short take-off distance, high lift coefficients must be generated which enable the machine to fly at very slow speeds. In fact, STOL flight invariably employs speed regimes during which the aircraft is flying on the "back side" of the power-required curve.

These low speeds are invariably associated with a lack of natural controllability and a very high sensitivity to gusts and small surface winds which would not at all affect higher-wing-loaded, higher-landing-speed aircraft. Powered control systems must be considered equally necessary for these STOL's as they are for VTOL's. In fact, the STOL control system may involve more stringent requirements than the VTOL.[1]

[1] As indicated by C. W. Meshier, "American Development in STOL and VTOL Aircraft," AGARD Report No. 86: "The problem of providing control power for hovering flight in VTOL aircraft is an obvious one. Not so obvious, perhaps, is that presented by the STOL aircraft. Such aircraft flying on the 'back side' of the power-required curve during landing approach and immediately following take-off will be operating in a regime where gusts, wind shifts, and incorrect plotting techniques can quickly place the aircraft at an airspeed where it cannot sustain itself at landing-speed power levels. If it relies on conventional aerodynamic surfaces outside the slipstream for control, the pilot can easily lose control under these conditions. Therefore even STOL aircraft which are normally operated at finite airspeed will require means of control effective at zero airspeed if practical operation from short fields under adverse weather conditions is to be realized."

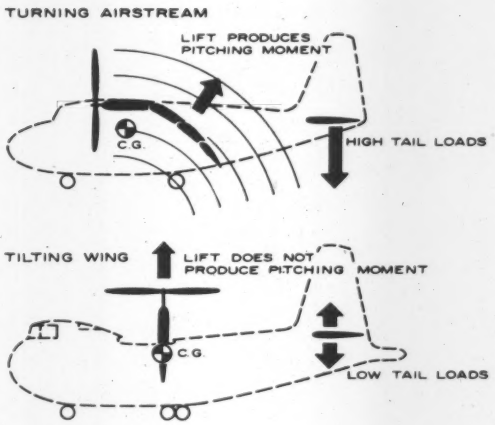

Fig. 7 Tilt wing versus flap-deflected slipstream lift-efficiency comparison

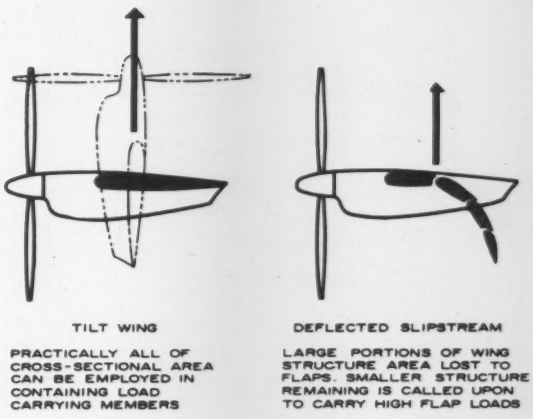
TILT WING
PRACTICALLY ALL OF CROSS-SECTIONAL AREA CAN BE EMPLOYED IN CONTAINING LOAD CARRYING MEMBERS
DEFLECTED SLIPSTREAM
LARGE PORTIONS OF WING STRUCTURE AREA LOST TO FLAPS. SMALLER STRUCTURE REMAINING IS CALLED UPON TO CARRY HIGH FLAP LOADS

Fig. 8 Tilt wing versus flap-deflected slipstream structural comparison

It is extremely beneficial if the powerful controls needed in the very low-speed regime can be generated by the already powerful basic lifting system. Generating these control forces with an auxiliary power system adds dead weight. The tilt-wing attains very high control forces during hovering and at low speeds in both roll and yaw by differential propeller action and aileron action. The auxiliary power system required only for pitch control can be either a shaft-driven horizontal tail propeller, an auxiliary turbojet engine, or bleed flow from the basic power-plant system.

By its nature the STOL concept defines an underpowered aircraft! A 500-ft-take-off STOL (not at all marginal by airplane standards when taking off with a 1000-ft run) is *just* capable of taking off in the 500 ft for which it is designed. Military specifications for all types of STOL's require take-off vertically at 6000 ft on a 95-F day. This must be done with one engine out in most instances. STOL proponents have not dared specify such stringent requirements.

The take-off performance of a typical tilt-wing propelloplane is even more remarkable. It is designed to take off vertically with one quarter of its power sections inoperable, Fig. 9. The STOL obviously has a superior useful-load ratio when accomplishing a normal mission; however, the overload capabilities of the VTOL are far superior. The greater structural ruggedness of the VTOL permits it to carry payloads which would far overstress the STOL's relatively frail structure.

The STOL with all engines operating is superior to the VTOL only for take-offs between approximately 800 and 1900 ft. The VTOL is superior for all higher or lower take-off distances.

Operational and Safety Aspects

The tilt-wing propelloplane has remarkable similarities with conventional airplanes for normal-airplane-type missions with the wing left in the horizontal position. The components are airplane-type components and the handling characteristics are those of an airplane though admittedly one of extremely high power and performance.

During the hovering regime, roll control is accomplished by differential thrust of the turboprops on either side of the fuselage. Yaw control is accomplished by the ailerons which are in the downwash. Because there is no airflow over the tail surface, a powerful pitch control is required. The small turbojet in the tail of the aircraft employed to provide hovering pitch control is illustrated in Fig. 1. A deflector system on the tail pipe of the turbojet allows the thrust to be deflected either upward or downward. A small horizontal tail propeller, mechanically driven by the main engines, could also be employed.

In forward flight, the wing is tilted down and the aircraft employs conventional airplane-type controls. During transition, the elements of both hovering and forward-flight controls are automatically blended by a fully mechanical mixing linkage. The only additional control to those for a normal aircraft is a lever to raise or lower the wing and a starting and stopping switch for the tail-control engines. Once the propelloplane is in forward flight, the pilot can switch off the hovering pitch-control system.

The lack of autorotational capabilities raises the problem of power-plant reliability. In all of the designs the company has investigated so far, the ability to hover at 6000 ft with 95-F ambient temperature with one engine out has been provided. The weight penalty required to practice such safety in any given design is reduced by employing a large number of small engines. However, carrying this procedure too far results in complex installation problems and high cost, and ultimately results in reduced reliability because the chances of having an engine failure are increased. Instead, the minimum number of engines compatible with multiengine reliability has been analyzed.

At present, the optimum balance is considered to be: (*a*) In small two-propeller machines—two engines would drive each propeller with a crossover shaft interconnecting the two nacelles, and hovering capabilities would be on the basis of one engine out; (*b*) in somewhat larger designs requiring a longer wing span—four propellers may be employed with one engine driving each of the propellers, again with crossover shafts; (*c*) in very large machines—four propellers could be employed with two

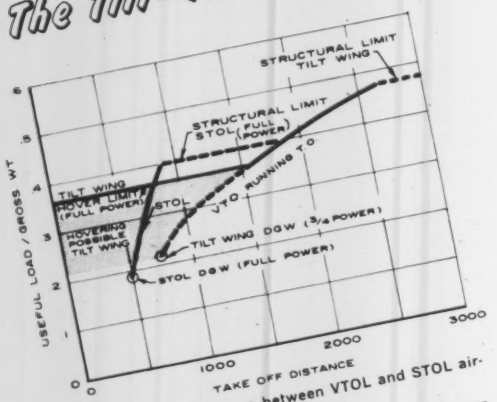

Fig. 9 Comparison between VTOL and STOL aircraft

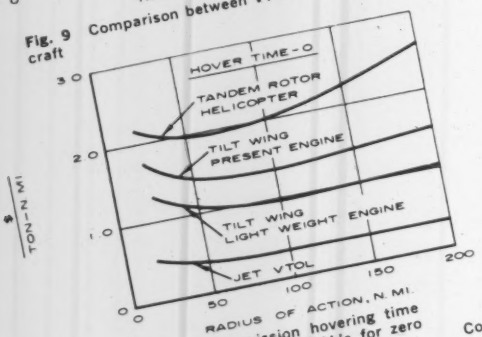

Fig. 10 Effect of mission hovering time on the economics of the VTOL's for zero hover time

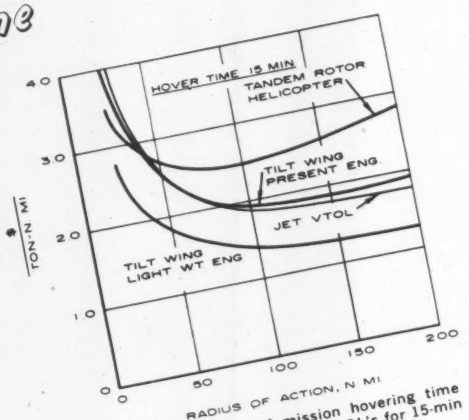

Fig. 11 Effect of mission hovering time on the economics of the VTOL's for 15-min hover time

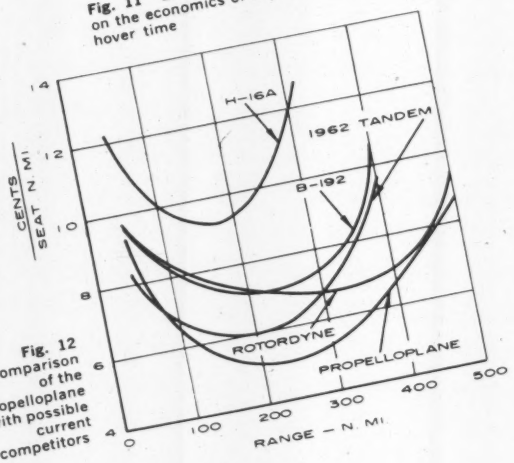

Fig. 12 Cost comparison of the propelloplane with possible current competitors

engines driving each propeller but with no crossover shafts; in this case an engine failure on one side may be compensated by a power reduction on the other side or by shutting down the equivalent engine on the other side; as with the smaller designs, the aircraft can fly with three quarters of the power plants operating.

In these designs, the propellers, transmissions, and drive shafts are being depended upon as primary reliability items. There are, of course, certain flight zones in which a failure of one of these items would be critical. However, in forward flight at reasonable altitudes mechanical failures are relatively harmless. The propelloplane is so overpowered compared with existing airplanes that it could continue to fly as long as one engine is still left to drive one propeller.

Economics

Economics is the only ultimate measure that will indicate whether an aircraft will or will not obtain acceptance. Figs. 10 and 11 show the dollar-per-ton-mile costs (military) for three types of VTOL aircraft carrying a 2500-lb payload. Costs for a mission requiring no hover time are shown in Fig. 10, and for a mission requiring 15-min hovering time in Fig. 11.

It is obvious that for zero-hover-time missions the turbojet-powered VTOL is superior, but, as some hovering time becomes necessary, the turboprop-powered types become more economical. The direct operating costs per seat mile of the tilt-wing-propelloplane type are compared with various helicopters which represent immediate-future VTOL competitors in Fig. 12.

The turbojet-powered VTOL types are not shown. They will not become operationally acceptable until adequate traffic-control and teminal systems eliminate the need to hover or fly slowly for more than just a few minutes per flight. When these become available, there is no question that turbojet-powered VTOL's will replace a percentage of turboprop-type VTOL's. That day is far off, and in the meantime this period seems to be earmarked for the tilt-wing propelloplane.

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SMALL FREE-PISTON ENGINE COMPRESSOR

By J. H. McNinch,[1] W. W. Vogelhuber,[2] and R. J. McCrory[3]

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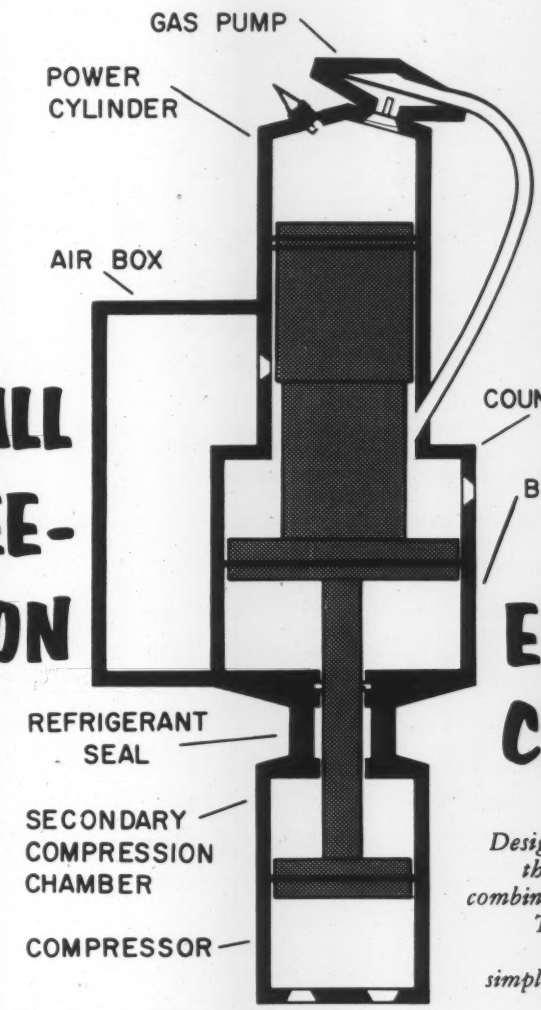

Fig. 1 The free-piston engine compressor. The counterchamber provides pressure for the fuel-injection system and also supplies the engine scavenging air.

Designed for residence air-conditioning, this gas-fueled engine compressor combination has only one basic moving part. The free-piston concept leads to a machine that is simple, efficient, compact.

In determining the most efficient method of utilizing natural gas for an air-conditioning system, investigation showed that one of the most effective means was to combine an internal-combustion engine with a vapor compression cycle. The free-piston configuration was selected for this combination because its inherent simplicity made possible low initial cost with the quality required for long service life.

With natural gas as the intended fuel, a spark-ignition Otto cycle is the logical choice. The low cylinder pressures and consistent output of this cycle are both desirable features. Because a free-piston engine must operate on a two-stroke cycle, fuel injection is required for safe and economical operation as well as for one-stroke starting.

A residential air-conditioning unit must have automatic starting and must operate with complete stability over the range of load conditions. A low noise level is required, and the unit must transmit no vibration.

The Basic Design

Fig. 1 shows the latest configuration of the free-piston engine compressor, a single-piston machine with a power cylinder at the top and a refrigerant compressor at the bottom. The stepped construction of the piston creates three chambers in the central portion of the unit. Both the bounce and secondary compression chambers control the stroke limits of the piston.

The gas pump, which is located on the engine cylinder head, is a pneumatically actuated diaphragm pump

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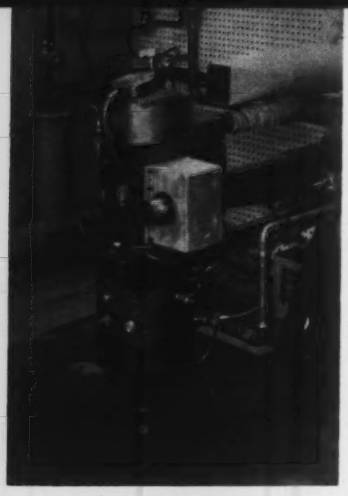

Fig. 2 The laboratory free-piston engine compressor. Both the engine and compressor have a bore of 2.75 in., and the nominal stroke is 3 in.

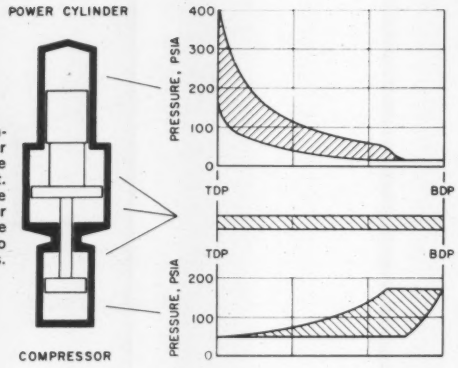

Fig. 3 Representative indicator cards of the free-piston unit. The area of the power cylinder card equals the area of the two lower cards.

with a spring-loaded poppet valve opening into the power cylinder.

The ignition system is a conventional automotive spark-coil system, the breaker points actuated by a piston-driven cam. This system has proved quite satisfactory in the laboratory installation; however, a more suitable spark ignition system has been developed specifically for the residential application.

To tie in with the air-cooled condenser of the air-conditioning system, the engine is also an air-cooled unit. Because there are no bearings, the engine is lubricated by the direct application of oil to the cylinder wall from a pressurized oil tank.

Little mechanical noise is present in the unit; therefore the major silencing efforts have been directed at the intake and exhaust systems. Both of these are wholly pneumatic noises, and the unit is currently operating at a reasonable noise level with commercially available silencers. A further reduction in noise level can be obtained if it is found necessary in the final installation of the unit in a residential area.

Operation. Prior to starting, the piston is held at the top of its stroke by the refrigerant pressure in the compressor. To start the unit, the piston is drawn down to the lower limit of its stroke. At this point, the gas pump contains a full charge and the power cylinder is filled with air. Refrigerant at system pressure forces the piston up on the starting stroke. After the piston covers the exhaust ports, the gas pump injects a metered charge of fuel into the power cylinder where it is mixed with the air. Ignition occurs near the top of the stroke.

The expansion of the high-pressure gases drives the piston down to compress the refrigerant contained in the compressor. As the piston nears the bottom of the stroke the exhaust and inlet ports open and the power cylinder is scavenged by air from the air box. The refrigerant pressure again drives the piston upward and the cycle repeats.

Fig. 2 shows the free-piston engine compressor that is operating in the laboratory. At the design speed of 1500 cycles per min, the free-piston unit produces approximately 3 tons of refrigeration. The over-all efficiency is high with over 75 per cent of the heat input being converted to useful cooling effect in the evaporator.

As a Dynamic Machine

The free-piston machine is a simple spring-mass system that has both positive and negative damping. Because there are no mechanical connections to the piston, its motion is a function of the gas forces imposed by the various chambers, and the energy is transferred between the working chambers by means of the kinetic energy of the piston rather than a direct transference of force. A complete energy balance must be maintained for every stroke of the piston. The operating speed is a function of the piston mass and the effective spring rate of the combined gas forces.

Over-All Energy Balance. Fig. 3 shows representative indicator cards of the power cylinder and the compressor. Because the bounce and secondary compression chambers absorb essentially no work, they have been combined with the counterchamber and mechanical friction to produce the rectangular "indicator card" shown between the cards of the two working chambers. To provide an over-all energy balance, the area of the engine card must equal the area of the two lower cards under all conditions of operation. Any change in the area of the compressor indicator card must, therefore, be accompanied by an equal change in the area of the engine indicator card which is dependent on the amount of gas delivered to the power cylinder.

A fuel system that would provide a modulated load would add substantially to the cost of the unit, particularly if a constant air-fuel ratio were to be maintained. These problems have been eliminated by operating the unit at a constant load. A simple constant-delivery fuel pump and a fixed scavenging system are employed, and operation over a wide range of load conditions is possible.

The constant-load characteristic of the compressor is obtained by using a compressor compression ratio[4] that is matched to the load characteristics imposed by the air-conditioning system. The suction pressure of the unit is the same as the evaporator pressure, which

[4] The compression ratio is defined as follows: The compressor volume at TDP divided by the compressor volume at BDP.

Table 1 Cyclic Energy Balance of the Free-Piston Unit
Discharge pressure—150 psia

	Down-stroke energy, in-lb	Upstroke energy, in-lb	Net energy, in-lb
Power cylinder	+1745	−415	+1330
Counterchamber	+415	−685	−270
Bounce chamber	−775	+775	0
Secondary compression chamber	+305	−305	0
Compressor	−1535	+725	−810
Friction	−155	−95	−250
Total	0	0	0

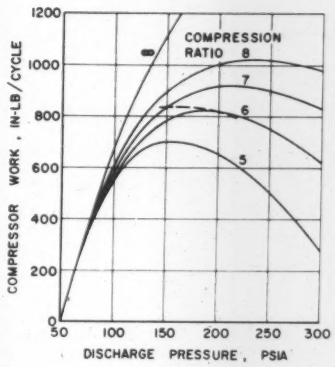

Fig. 4 Compressor work as a function of discharge pressure; Refrigerant 12, suction pressure 50 psia, displacement 17.8 cu in.

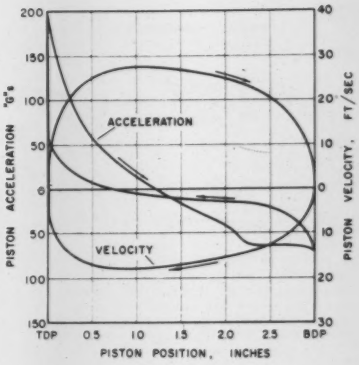

Fig. 5 Acceleration and velocity profile of the free-piston unit. The high accelerations at the ends of the stroke result in the somewhat squarish velocity profile.

can be held essentially constant with an automatic expansion valve. On the other hand, the discharge pressure, which is a function of the saturation temperature of the condenser, varies directly with the ambient temperature in an air-cooled unit. With Refrigerant 12, the design evaporator pressure is 50 psia and the condenser pressure varies from 150 to 200 psia.

Fig. 4 shows compressor work as a function of discharge pressure. At any given compression ratio there is a range of discharge pressures where the compressor work is essentially constant. With a 7:1 compression ratio, the compressor work would be increased by less than 15 per cent as a result of raising the discharge pressure to 200 psia. The compression ratio of the free-piston unit does not remain constant but decreases slightly as the discharge pressure increases. This decrease, which is shown by the dashed line in Fig. 4, maintains the compressor work at a nearly constant level throughout the operating range, thereby providing the desired constant load operation.

Cycle Energy Balance. In the over-all energy balance, the three central chambers of the unit were combined with mechanical friction to produce a net energy loss. The counterchamber is the only one of the three that absorbs any appreciable work; the other two act merely as springs. However, when the energy balance is considered on a cycle or stroke basis, the energies involved in these chambers must be considered.

On each stroke of the piston some chambers expand to add energy to the piston while others compress to remove energy. In all cases, the expansion energy equals the compression energy plus the friction losses of the piston. Table 1 shows the cycle energy balance for the free-piston engine compressor when operating at a 150-psia discharge pressure.

Table 1 brings to light several points. Although the bounce and secondary compression chambers do no net work, they account for 22 per cent of the energies on the downstroke and 36 per cent on the upstroke. This high energy level produces no problems and, in fact, it provides a simple means of transferring energy between the two strokes of the cycle. The net energy column has been included to show the tie-in to over-all energy balance. The energies in this column represent the indicator cards shown in Fig. 3. Based on these energies, the "mechanical efficiency" of the unit is 61 per cent which is the equivalent of engine and compressor mechanical efficiencies of 78 per cent.

Operating Dynamics. The operating dynamics of the free-piston engine are determined by the combined gas forces of the various chambers. The acceleration and velocity profile shown in Fig. 5 illustrates the dynamic characteristics of the unit when operating at a discharge pressure of 150 psia. In a free-piston unit the acceleration of the piston is directly proportional to the combined gas force. At the upper portion of the piston stroke the acceleration profile bears a strong resemblance to an engine indicator card while the lower portion is closely related to a compressor indicator card. Both the maximum piston speed at mid-stroke and the "dwell" at the upper and lower dead points are lower than those that would be obtained in a crankshaft unit operating at the same cyclic speed.

Another important characteristic of the piston velocity is that the speed of the downstroke is approximately twice that of the upstroke. This is typical of a free-piston unit which compresses on the engine power stroke due to the higher energy level that exists during this stroke. Both the squarish and asymmetrical characteristics of the velocity profile have been considered in the design of components such as the fuel-injection system and the compressor valving.

The operating dynamics of the free-piston engine-compressor are summarized in Table 2.

As the discharge pressure is raised from 150 psia to 200 psia, the piston acceleration is increased during the lower portion of the stroke. This increases the spring rate of the system and results in the slightly higher operating speed. In order to maintain the cycle energy balance, both the stroke limits shift toward the upper end of the unit to raise the engine compression ratio and decrease the compressor compression ratio. This latter change results in the unit following the "constant work" line (dashed) shown in Fig. 4.

Suspension. The use of the single-piston configuration is dictated by low initial cost necessary in a residential air-conditioning unit. A single-piston unit is completely unbalanced due to the gas forces which act directly on the heads of the two cylinders.

Table 2 Summary of Operating Dynamics

Discharge pressure, psia	150	200
Operating speed, cpm	1500	1650
Engine compression ratio[5]	6:1	7-1/2:1
Compressor compression ratio	7:1	6:1
Compressor work, in-lb/cycle	820	810

[5] The engine compression ratio is defined as follows: The power-cylinder volume at exhaust-port closure divided by the power-cylinder volume at TDP.

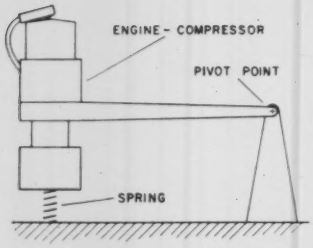

Fig. 6 The pivot-point suspension system. The centerline of the engine compressor passes through the center of percussion of the suspended mass.

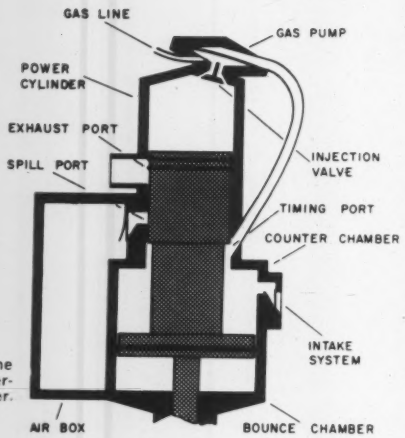

Fig. 7 The gas-injection system of the free-piston unit. The gas pump is operated by air from the counterchamber.

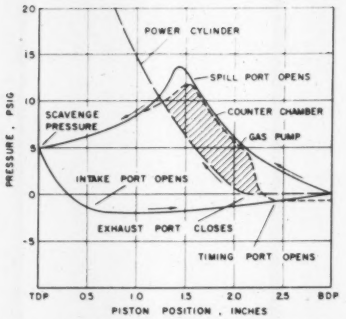

Fig. 8 Pressure characteristics of the gas-injection system. The shaded area represents the 5-psi pressure differential used to inject the fuel.

The approach taken was to use the mass of the engine to absorb these forces, allowing the engine freedom of motion along its centerline and supporting the static load on a soft spring which isolates the unit from the base structure. Operated in this manner, the engine has a velocity profile which is a mirror image of the piston profile except that it is of a lesser magnitude.

The pivot-point suspension system shown in Fig. 6 allows the engine compressor the required freedom while providing a simple means of making the necessary connections. Reactions at the pivot point are eliminated by locating the unit's centerline at the center of percussion of the suspended mass. Because the connections are taken out across the pivot point, they are subjected to little angular deflection.

Fuel Injection

Fuel injection is necessary to obtain economical and safe operation of a two-stroke cycle engine. By injecting the fuel directly into the power cylinder after the exhaust ports are closed, all of the fuel is available for the combustion process and no raw gas escapes to the exhaust system.

The fuel is a gas which is available at essentially atmospheric pressure; therefore, a relatively large volume of fuel must be handled, and the injection pressure must be developed by the free-piston unit. The emphasis on low initial cost and the small size of the unit place a severe restriction on the addition of any components to the basic unit.

Fig. 7 shows the basic gas-injection system. The gas pump is a pneumatically operated diaphragm pump with its displacement set by the upper and lower pump surfaces. Fuel is drawn in from the pressure-regulated gas line and discharged through the injection valve directly into the combustion chamber. The fixed displacement of the pump combined with the regulated pressure of the gas line provides accurate metering of the fuel charge. The timing ports, which connect the counterchamber to the gas pump at a definite point in the cycle, determine the start of the injection period.

When the piston moves upward, the air in the counterchamber is compressed while the power cylinder remains at essentially atmospheric pressure. As the exhaust ports close, the timing ports admit the counterchamber pressure to the gas pump, where it is transferred to the fuel by means of the pump diaphragm. The spring-loaded injection valve is forced open and the fuel charge is injected into the cylinder. When the diaphragm reaches the end of its travel, the fuel pressure drops and the injection valve closes. After the injection period is over, the spill ports are opened to discharge the air from the counterchamber through a set of reed valves into the scavenge air box. Both the counterchamber and the scavenge air box are at scavenge pressure when the piston reaches the top of its stroke.

As the piston moves down, the counterchamber pressure falls until the piston uncovers the intake ports to draw in a fresh supply of air through the intake reed valves. The subatmospheric pressure thus created returns the pump diaphragm to draw in a fresh charge of fuel. When the piston reaches its lower dead point, the gas pump contains a full charge and the counterchamber is again at atmospheric pressure.

The pressure characteristics of the gas pump are shown in Fig. 8. Sufficient injection pressure has been obtained with a nominal counterchamber displacement by minimizing the clearance volume of the gas pump and carefully balancing the flow areas of the connecting passages against the clearance volume added to the system. The timing port opens ahead of the exhaust port closure to offset the time delay created by valve and diaphragm inertia, effective port opening, and time required for the gas to cross the power cylinder.

Summary

This paper has briefly covered the dynamic and power-generation aspects of a free-piston engine compressor that is intended for use in a residential air-conditioning system. The requirements of low initial cost, high efficiency, and compactness are met by the free-piston unit with its pneumatically operated fuel-injection system.

It is important to note that the unit was developed for a specific application; however, this does not necessarily limit the free-piston engine compressor to residential air conditioning. Changes would be required for other applications. This development program has shown that the small free-piston unit has promise if designed to meet the specific requirements of its intended use.

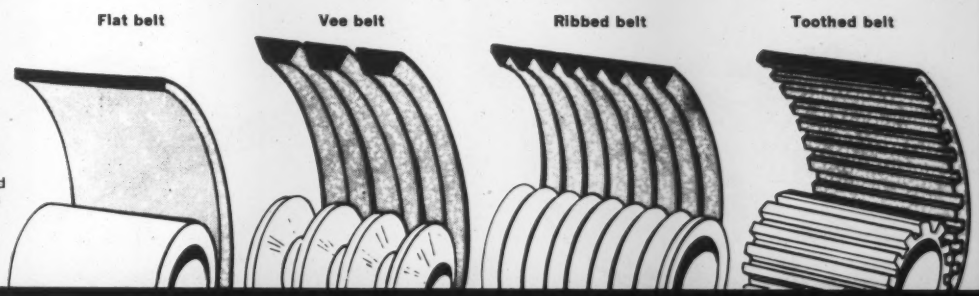

Fig. 1 Load-carrying capacity and life of the well-known vee and flat belts have been enhanced by new materials

MECHANICAL POWER TRANSMISSION

No one type of drive is categorically superior to others. Here is a state-of-the-art briefing, a condensed report on mechanical drives.

Belts, Chains, and Gears[1]

By E. S. Cheaney,[2] C. L. Paullus,[2] and W. C. Raridan[2]

BECAUSE of the many means available for the transmission of power, the engineer is faced with ever-increasing complexity in his search for an optimum design which balances three important factors: function, life, and cost. Advances are being made through the use of new materials, improved manufacturing techniques, and advanced product ideas.

A bibliography at the end of this paper lists 42 references which discuss in detail the points which will be mentioned here.

Transmission Types

Belts. Fig. 1 shows four types of belt drive. A high rate of technical advance is being maintained in the field. Example: The addition of a plastic inner ply in one type of flat belting. The ribbed belt is the successful result of efforts to combine the flat belt's advantages of strength and simplicity, and the high grip and positive groove-tracking of the vee belt. The toothed belt has rapidly found wide acceptance because of its positive drive and high-speed ratings.

The readiness with which wide-section vee belts can be adapted to infinitely variable speed drives has led to many machines which embody this feature. A recent interesting application of variable-speed vee belts is in the transmission of the DAF automobile now being manufactured in Holland.

Chains. Continual improvements in materials, heat-treat processing, and close tolerance manufacturing methods have resulted in chains, Fig. 2, which have higher strength and longer life.

A recent innovation is the bead chain, Fig. 2(*e*), as a power-transmitting device for low speed and power. Bead chains are versatile with respect to shaft alignment, and can be operated on shafts which have been skewed as much as 90 deg. Bead chain also can drive intersecting shafts up to an included angle of 40 deg. Another development is an inverted-tooth silent chain, Fig. 2(*d*), which has a rocker joint at the point of articulation. It is claimed that the design of the rocker joint is such that chordal action is eliminated so that uniform motion is imparted to the driven sprocket.

A unique chain drive is the infinitely variable silent chain drive shown in Fig. 2(*f*). This drive embodies a tooth-forming chain which operates between grooved conical wheels. The sheave halves can be moved in and out, so that the ratio is changed as the chain is forced to ride on a greater or smaller pitch diameter.

Gears. Developments in gearing are now pointed toward three objectives: Greater capacity for a given size; greater speed capability; improved reliability.

Increasing emphasis on light weight, not only in aircraft and missile equipment, but also in appliances, automobiles, and other consumer products accounts for the efforts to reduce the size of gears and at the same time increase their capacity.

Fig. 3 illustrates the variety of forms in which gearing is available.

The gear pairs shown in Figs. 3(*b*) and 3(*c*) have shafts which are normal to each other, but any included angle can be accommodated with these gear types.

The tapered worm gear is a recent addition to the family of skewed-axis gear types. The tapered pinion

[1] Condensed from ASME Paper No. 59—MD-5, "The Design and Application of Belts, Chains, and Gears."

[2] Principal engineers, Battelle Memorial Institute, Columbus, Ohio. Based on two papers contributed by the Machine Design Division and presented at the Design Engineering Conference, Philadelphia, Pa., May 25–28, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

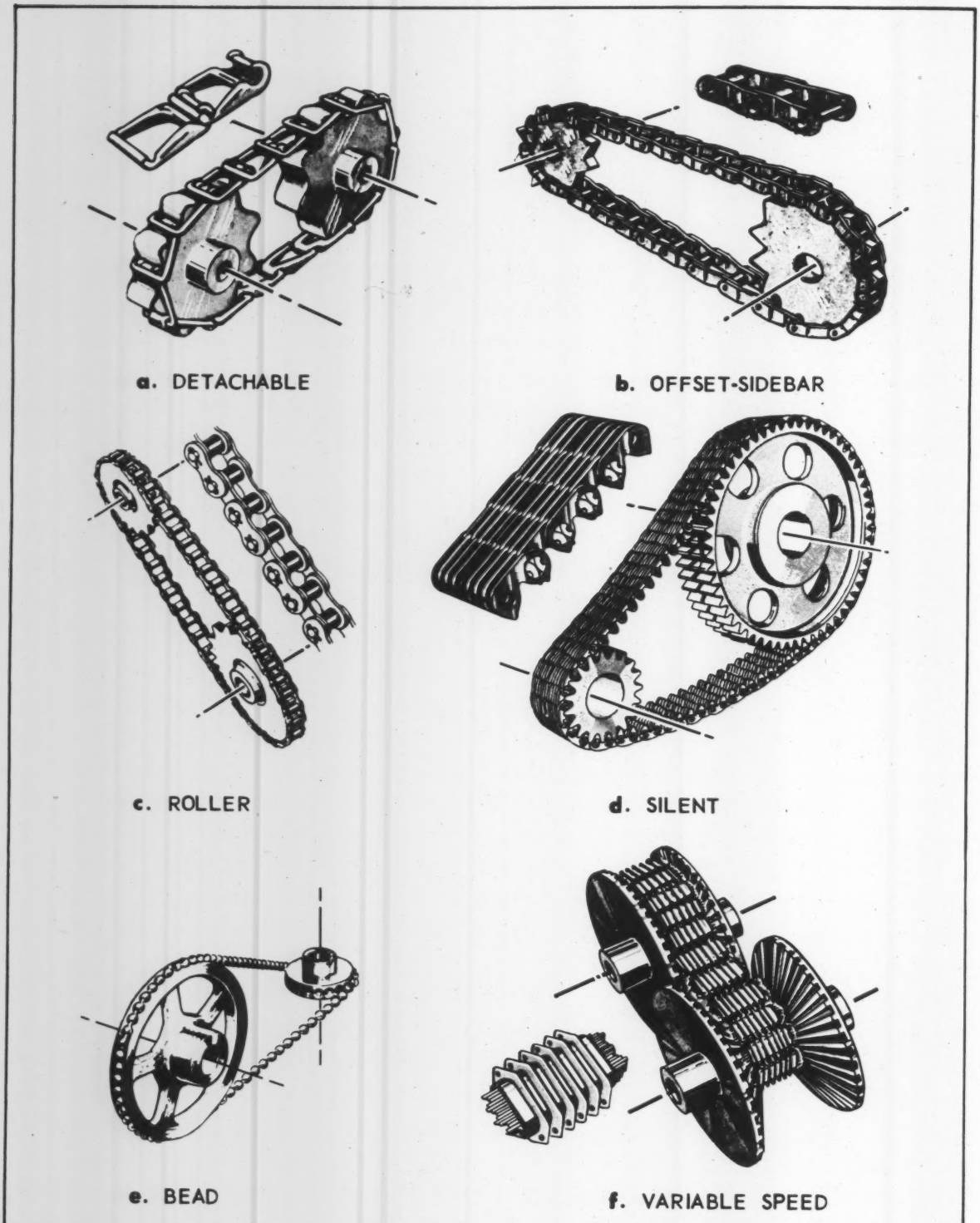

Fig. 2 Chains are now available in a variety of materials, such as stainless steel, for high temperatures, corrosion, and other special conditions

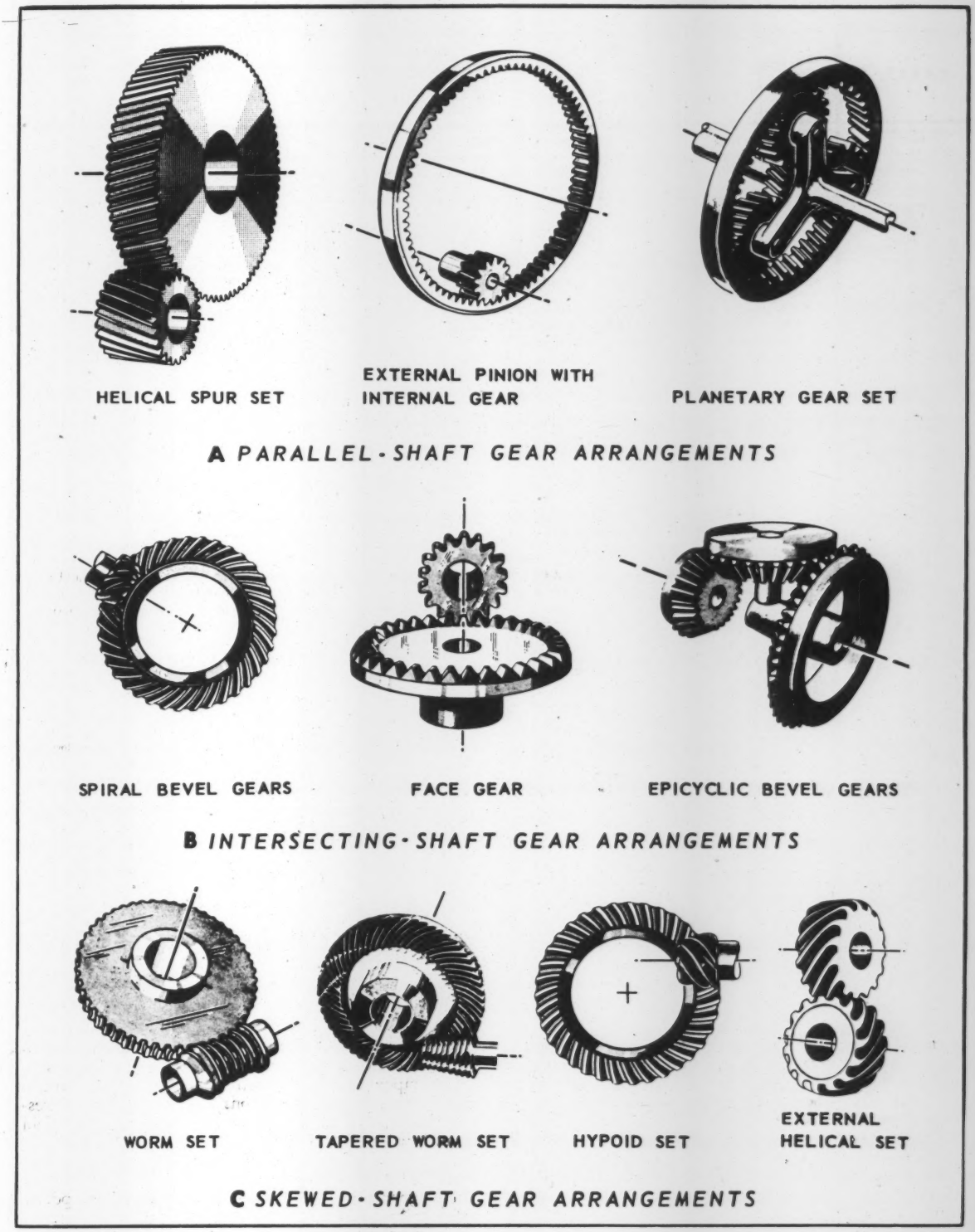

Fig. 3 These gear pairs are arranged to show a popular method of classifying gear types—the geometric orientation of the connecting shafts

Table 1 Properties and Capabilities

TABLE 1		BELTS						CHAINS					
		Leather (Flat)	Rubber Fabric (Flat)	Plastic Core (Flat)	Standard (Vee)	Steel Cable (Vee)	Toothed	Bead	Detachable	Pintle	Offset-Side-Bar	Inverted Tooth (Silent)	Roller
GENERAL DESIGN FACTORS	Ratio	16:1	16:1	20:1	12:1	12:1	11:1	–	2-1/2:1	2-1/2:1	4:1	12:1	8:1
	Speed (Feet per min.)	6000	13,000	24,000	5000	8000	15,000	200	350	450	1000	6500	5000
	Load (Equivalent width)	5.9	–	–	6.7	–	3.0	–	–	–	–	1.9	1.6
	Life	Depends on speed, pulley diameters, tension and total belt length. Published data and selection procedure available for vee belts. Generally less than 15,000 hours.						Catalogue selections based on 15,000 hours.					
	Center Distance	Independently variable — no interrelationship between pulley diameters and distance. Wear and retensioning takeup adjustment must be provided either by adjustable center distance or extra mechanism.						Independently variable — no interrelationship between sprocket diameters and center distance for a given ratio. Wear takeup required.					
SPECIAL DESIGN FACTORS	Shaft Relationship	Connected shafts can be skewed up to 180° but belt capacity and life will be reduced accordingly.						Connected shafts can be skewed up to 90°	Connected shafts must be nominally parallel.				
	Ratio Accuracy	Subject to slip and creep. Normal amounts are 1 to 5 % but amounts vary widely with tension ratio and contact pressure.					Delivers a fixed ratio	Delivers a fixed ratio. Instantaneous velocity ratios vary cyclically with chordal action					
	Vibration and Noise	Generally free of vibration. Subject to noise due to belt slap.			Quiet and free of vibration.		Vibration frequencies generated by tooth action	Noise and vibration are inherent due to chordal action. Large diameter sprockets, flywheels, and special silent chain designs can minimize but do not eliminate chordal action effects.					
	Efficiency	Up to 98% at rated steady load. Efficiency will reduce with varying load.						96 – 99%					
	Lubrication	No lubrication required.						Capable of dry operation for short-life applications or low load. Best life is obtained with splash or drip lubrication.					
	Environment	Practically any environmental condition can be met by proper selection of material. Temperature range –60 to +225° F.						Can be operated in abrasive atmosphere with somewhat reduced life.	Cannot be operated open in abrasive atmosphere. Special materials are available for various types of corrosive atmospheres. Temperature range: –60 to 600° F				
	Maintenance	Retensioning	Retensioning	Periodic application of special belt conditioner	Retensioning	Retensioning	–	Lubrication, retensioning and wear takeup.					

permits engagement with mating teeth generated on the face of a bevel gear. This arrangement provides a new and practical right-angle gear relationship, filling the gap that existed between shaft arrangements suitable for hypoid gears and worm drives. The gears can be produced on standard generating tools and have advantages of multiple tooth contact and wide ratio range.

Experience in gear design gained in the development of automatic automobile transmissions has resulted in significant advances in the art of machining, mounting, and specifying materials for mass-produced gears. The development of high-speed prime movers of the turbine type in aircraft, automotive, and marine fields has necessitated the use of ever-increasing pitch-line velocities.

The importance of gear reliability has become prominent in the design of weapons systems, aircraft accessory drives, and various drive applications in the field of nuclear energy.

Design Procedure

As a general rule, the designer will know the power to be transmitted, the over-all speed ratio, the rpm of one of the shafts, and the life requirement of the drive.

Special restrictions or requirements may exist which

TABLE 1

GEARS											
Parallel Shaft			Intersecting Shaft			Skew Shaft					
Straight Spur	Helical	High-Speed Herringbone	Straight Bevel	Spiral Bevel	Face Gear	Worm	Tapered Worm	Hypoid	Crossed Helical		
6:1	10:1	15:1	4:1	4:1	10:1	75:1	200:1	6:1	–	Ratio	GENERAL DESIGN FACTORS
4000	10,000	30,000	4000	8000	–	6000	6000	8000	6000	Speed (Feet per min.)	
1.0	–	–	–	–	–	–	–	–	–	Load (Equivalent width)	
Substantial quantity of life information is available. Consult latest AGMA publications. Can be greater than 15,000 hours.										Life	
$CD = \frac{D+d}{2} = \frac{d(R+1)}{2}$ CD = center distance d = pinion pitch diameter D = gear pitch diameter R = Ratio			No center distance since shafts intersect.			Center distance is not directly related to ratio or pitch diameter.				Center Distance	
———			Any included angle can be used.		Normally 90° angles are used	90° skew angle			Any skew angle	Shaft Relationship	SPECIAL DESIGN FACTORS
All gearing delivers exact ratio. Instantaneous velocity is theoretically uniform — any variation is due to profile and spacing inaccuracies.										Ratio Accuracy	
Frequency generation is inherent due to tooth contact. Practically noiseless drives can be achieved by special design and fabrication measures.										Vibration and Noise	
98 – 99%			95 – 98%		–	20 – 98% Varies with size and ratio		95 – 98%	Wide variation depending on sliding.	Efficiency	
Lubrication required to achieve high efficiency. Plastic and impregnated materials are available for low-load dry applications.										Lubrication	
Cannot be operated open in abrasive atmospheres. Fully enclosed gear sets fairly independent of nature of atmosphere (providing seals are satisfactory). Ambient temperature range –60° to +300° F										Environment	
Lubrication										Maintenance	

are not immediately apparent but must be uncovered by study of the environment of the drive and its specific function. Hospital machinery normally must be unusually quiet; equipment for the textile industry must not soil the goods; the drive for an experimental process machine must be capable of speed adjustment.

Table 1 will facilitate a comparison between specific drive requirements and the properties and capabilities of the principal belt, chain, and gear transmissions.

Ratio. The primary decision which must be made with respect to ratio is whether the drive must be stepped in several reductions or can be designed as a single reduction. There is no inherent quality about any of the three transmission types which sets up a ratio limit beyond which they will not function. On the other hand, few drives are built which exceed the ratios quoted in Table 1. Ratio limitations consist of three factors: space, cost, and efficiency.

The most common method of providing an exceedingly large ratio in one reduction is the worm drive. Certain epicyclic arrangements can produce ratios of 2000 to 1. Although quite compact, they are seldom efficient.

Speed. In a transmission of a given power level, the tangential speed and load are inversely related. These two quantities can be juggled until the optimum arrangement for the drive is realized. This will be the

one which gives the least costly drive utilizing the highest speed of which an economical drive type is capable. Table 1 shows the limiting speed, of the principal types and, incidentally, testifies to the great range of tangential speeds which can be handled today.

Belts are capable of satisfactory operation at high speed. Flat belts have been operated at speeds of 24,000 fpm. The principal limiting factor is tension developed in the belt by centrifugal forces. However, centrifugal force has less effect on belt capacity than previously assumed.

Chordal Action

Generally, chains cannot be run as fast as belts, and are limited in speed by the effect of impact loading. This loading occurs as the chain runs onto the sprocket forming a series of chords around the sprocket pitch line. Ingenious mechanisms have been devised, and some marketed, which reduce the effects of chordal action.

Speed limitation of gear drives is a function of tooth-profile accuracy, spacing accuracy, and the amount of tooth distortion under load. These errors cause impact as the teeth come into mesh, and the effect increases with pitch line speed. These effects have been minimized to permit gear speeds on the order of 30,000 fpm.

An important fact to remember is that speed affects reliability. In general, the slower the drive, the more reliable it is apt to be. Auxiliary components such as seals, bearings, and lubrication systems are similarly influenced by speed.

Load. If speed has already been selected, the nominal tangential load is directly proportional to the power requirement and will determine the cross sections of the load-carrying element. The principal problem is the establishment of the design load to be used in proportioning the drive parts. The design load, sometimes called the equivalent load, is usually computed by multiplying the nominal load by a service factor. The service factor is supposed to account for the variations from constant load conditions caused by the type of service of the machine, the nature of the prime mover, and the peculiarities of the duty cycle.

The effect of load as a selection parameter is expressed in Table 1 as a number which represents the width of a drive relative to a spur-gear width of unity for a drive of the same geometry, power, and speed. The spur gear used as a base for this part of the table was calculated from the procedure given in AGMA 210.01 Surface Durability of Spur Gears. The base gear was assumed to be of steel at 300 Brinell hardness. The service factor was set at unity, and manufacturers' selection procedures were followed for all the drives. The figures quoted are averages to indicate a relationship, and are not offered as design data.

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Clutch-Fluid Coupling-Hydraulic Torque Converter[3]

By R. W. Bachmann,[4] Assoc. Mem. ASME

THIS study reviews the various performance features of three basic power-transmission-drive devices—clutch, fluid coupling, hydraulic torque converter—with regard to standard industrial applications.

Fig. 4 illustrates schematically the basic elements of each of the three drives.

Clutch. The common friction clutch will transmit full power mechanically from the prime mover to the power-train member immediately behind the clutch. There should be no loss of torque or speed once the clutch is fully engaged, unless the slip torque of the clutch is exceeded.

Mechanical shock loads imposed on either the input or output member of a fully engaged clutch will be transmitted. The clutch will slip, however, if the torque peak of the shock load exceeds the slip torque. The same is generally true of torsional vibration.

Fluid Coupling. The fluid coupling will transmit full torque from the input member to the output member through its hydrodynamic circuit. There will be some loss of speed, dependent upon the torque being transmitted, due to the slip which is inherent in the hydrodynamic circuit. The fluid will damp out mechanical shock loads and torsional vibration.

The horsepower loss due to slip in the fluid coupling must be dissipated as heat in the fluid. In most industrial applications, if the fluid coupling is properly matched to the prime mover, the slip, and consequently the horsepower loss, are not excessive. In such cases the heat can be dissipated through convection to the metal shell, and by radiation from this shell to the atmosphere. For more heavy-duty applications, however, cooled couplings are available which incorporate a fluid pump and heat exchanger.

[3] Condensed from ASME Paper No. 59—MD-6, "Clutch—Fluid Coupling—Hydraulic Torque Converter . . . Application Considerations and Performance Comparisons."

[4] Application Engineer, Hydraulic Division, Twin Disc Clutch Company, Rockford, Ill.

Hydraulic Torque Converter. The hydraulic torque converter will give variable torque transmission, depending upon the load on its output member. Unlike the clutch and the fluid coupling the hydrodynamic circuit of the torque converter, which incorporates a stator or reaction member, can multiply the torque.

There will be loss of speed through the torque converter which will be more or less inverse to the torque multiplication; that is, at 100 per cent slip, or what is commonly referred to as stall condition, the torque multiplication, or torque ratio, is at its maximum. The torque converter will damp out mechanical shock loads and torsional vibrations in much the same sense as the fluid coupling.

The horsepower loss in the torque converter must be dissipated as heat in the fluid. Fluid piped in and out of the hydrodynamic circuit can be cooled by a heat exchanger in the external circuit.

One Engine, Three Transmissions

As an example, consider a hypothetical industrial internal-combustion engine—net performance shown in Fig. 5.

Consider full-throttle performance of the power unit under load, with the power unit consisting of the prime mover and each of the drive devices.

Output Torque. Fig. 6 is a plot of power-unit output torque versus output speed for the three drives. The torque multiplication provided by the torque converter is clearly indicated.

Engine Speed. Fig. 7 is a plot of engine speed versus power-unit output speed. The degree of engine lug-down is illustrated here.

With the pure clutch drive, if the load imposed by the driven machinery is sufficient to tend to stall out the power unit, the engine will be killed.

With the fluid-coupling drive, the engine is lugged down considerably but it will not be killed.

With the torque-converter drive, there is relatively

Fig. 4 The basic elements of power-transmission devices. The fluid coupling introduces slip, and the torque converter adds the element of torque multiplication—torque ratio (TR) in the diagram.

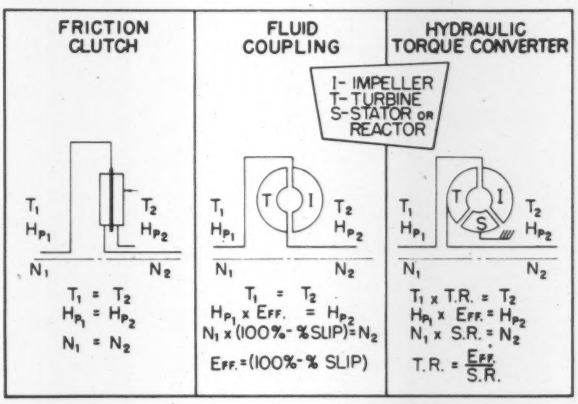
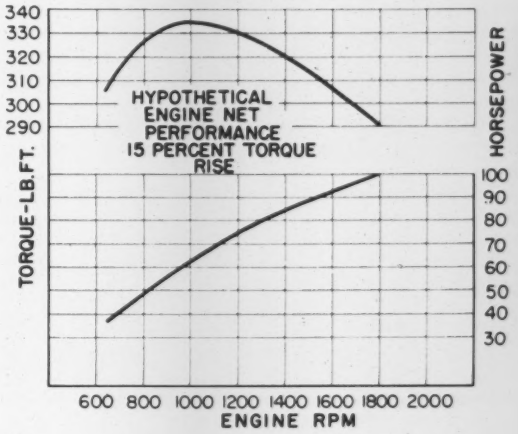


Fig. 5 The prime mover on which this study is based. Rating is 100 hp net at a governed speed of 1800 rpm. Torque rise is 15 per cent. Peak torque is at 1000 rpm. Assume 10 per cent governor overrun.



little engine lug-down, and the engine will certainly not be killed as the output shaft is stalled.

Engine Torque. Fig. 8 shows engine torque actually absorbed in relation to power-unit output speed. With the clutch or the fluid-coupling the engine may be lugged down such that peak torque will be required of the engine. With the torque converter, however, the engine-torque absorption is relatively constant throughout the output-shaft speed range back to stall.

Since brake-mean-effective-pressure (bmep) of an engine is proportional to engine torque, it can be seen from Fig. 8 that, with the clutch or the fluid-coupling drive, engine loading may be more severe than with converter drive if the driven machinery loads vary considerably. Maximum rise in bmep from engine-governed condition would be 15 per cent with the clutch or the fluid-coupling drive, and 4 per cent with converter drive.

Output Horsepower. Fig. 9 shows a comparison of output horsepowers. Output is virtually the same for the clutch drive and fluid coupling.

Peak output horsepower attainable with the clutch drive is, of course, full engine horse-power, or 100 hp. Peak with the torque-converter drive is 83 hp.

The Working Range

Peak horsepower available is not necessarily the major consideration. Consider the useful practical working range of power-unit output speed through which each of these drive devices could be operated continuously.

An engine with a plain clutch drive can operate very well near the governed speed of the engine or on the governor overrun, depending upon the load demand of the driven machinery. It can be lugged below governed speed as required to utilize the natural torque rise of the engine. The engire cannot be lugged continuously below the speed at which it produces maximum torque, however, without killing the engine. For our hypothetical engine with the plain clutch drive, the working speed range is from 1000 to 1980 output rpm.

With hydraulic drives, the limits of the working range are determined by the degree to which heat generated due to horsepower loss can be dissipated in the fluid. Fig. 10 is a plot of heat-to-be-dissipated versus power-unit output speed for the two hydraulic drives. The heat to be dissipated is determined by subtracting the drive output horsepower from the drive input horsepower at any given output speed, and converting the difference to Btu per min.

For torque converters, it is common practice to provide a heat exchanger for the fluid which can dissipate 30 per cent of the maximum net engine horsepower. This insures ample cooling to allow for continuous operation above 70 per cent converter efficiency.

Fig. 11 is the power-unit, output-horsepower comparison modified to indicate total horsepower only in the practical working ranges.

Since horsepower is an expression of the rate of doing work, or an expression of work per unit of time, the potential work available from the three drives under study can be thought of as being proportional to the areas under the horsepower curves.

Horsepower Ratio

If the rated average working horsepower for a given application is known or can be estimated with reasonable accuracy, the suitability of a drive can be reviewed on the basis of what is referred to as "horsepower ratio," defined as the ratio of the maximum to minimum output speeds at which rated working horsepower is available. It is an indication of the speed range over which a given minimum power-unit output horsepower can be maintained.

$$\text{hp ratio} = \frac{\text{min output rpm at rated hp}}{\text{max output rpm at rated hp}}$$

Fig. 12 is a plot of horsepower ratio versus rated load for the three drives. The use of a step-geared transmission behind these drives has been ignored, so far, because we have been analyzing the performance of each drive on its own merits, back to its own output shaft only. The use of a transmission, however, is important in some applications, such as vehicles, for further broadening the speed range and for maintaining a certain minimum horsepower. The horsepower ratio of a given drive at the minimum horsepower required will be indicative of the number of ratios and the steps between ratios required for such a transmission.

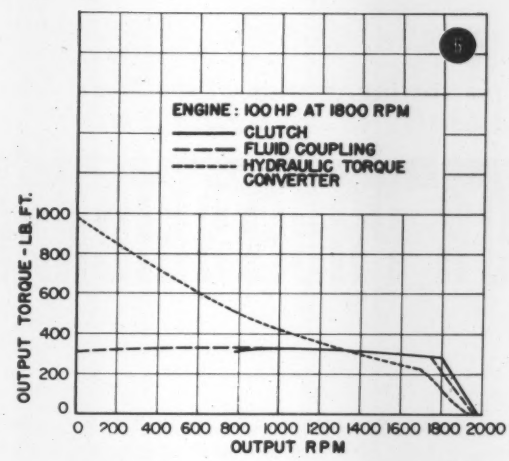
Shifting Gears

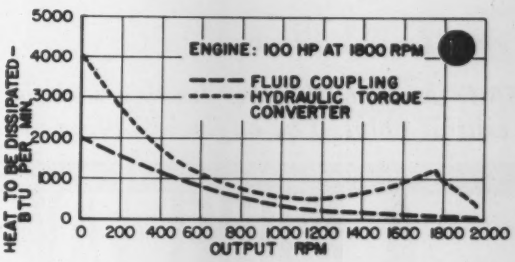
As a hypothetical case, Fig. 13 shows horsepower versus axle or wheel rpm, the latter being proportional to vehicle speed for a given wheel diameter. Performance is compared between a three-speed transmission for the clutch drive and a two-speed transmission for the torque-converter drive. The steps between ratios are equivalent to the horsepower ratios at 70 hp from Fig. 12—1.68 for the clutch drive and 2.77 for the converter drive. The converter drive maintains 70 hp over a slightly broader range with two ratios in the transmission than the clutch drive does with three ratios.

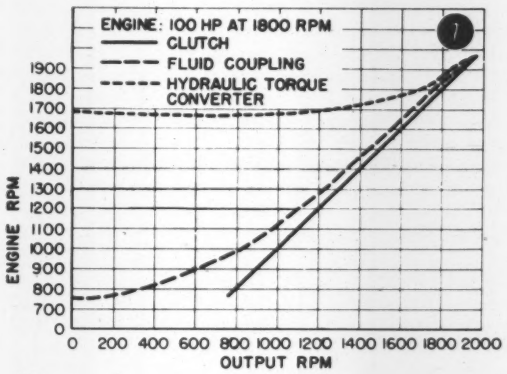
Table 2 lists the results of this study.

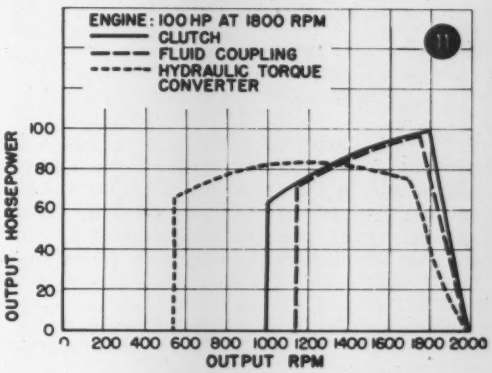
Table 2 Comparison Data

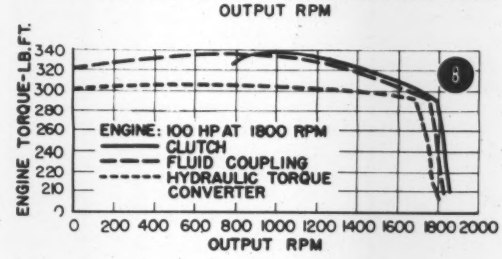
	Friction clutch	Fluid coupling	Torque converter
Transfer of shock and torsional vibration	Yes	No	No
Torque multiplication	No	No	Yes
HP loss	No	Yes	Yes
Speed loss	No	Yes	Yes
Max. output torque, lb/ft at output rpm	336 1000	336 825	985 0
Engine rpm at stall	0	750	1675
Engine rpm, beginning of working range Per cent of governed rpm	1000 55.6	1230 68.3	1660 92.2
Max. engine torque, lb ft	336	336	303.5
Engine torque, lb ft, beginning of working range	336	330.5	303.5
Per cent engine torque (and bmep) rise from governed condition (in working range)	15	13	4
Max. output hp at output rpm	100 1800	98 1755	83 1200
Method of heat dissipation	Radiation	Radiation	Heat exchanger
Heat to be dissipated, Btu/min, at stall		1950	4090
Heat to be dissipated, Btu/min, beginning of working range	Negligible	245	1270

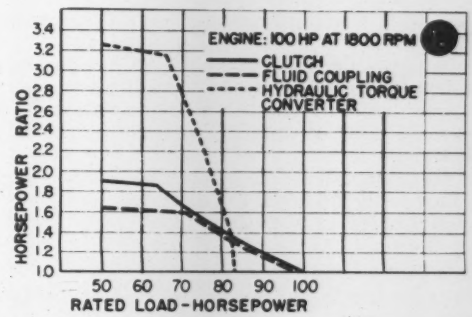


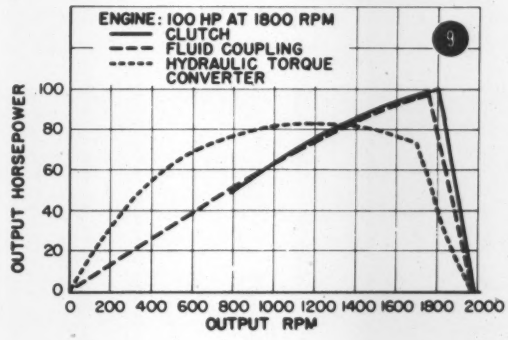


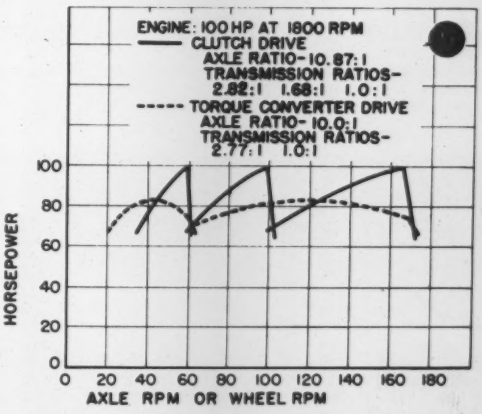












Figs. 6 through 11 show the characteristics of the three drives plotted against output speed. **Fig. 11** differs from **Fig. 9** in that it shows the practical working limits which, in the hydraulic drives, are determined by the extent to which heat generated due to horsepower loss can be dissipated in the fluid. Horsepower ratio, **Fig. 12**, is the ratio of the maximum to minimum output speeds at which rated working horsepower occurs. In **Fig. 13**, the converter with two-speed transmission maintains 70 hp over a slightly broader range than the clutch drive with its three ratios.

ASME works with other leading societies in the coming revision of the Model Law. A critical point: The engineer's place in a partnership or incorporated firm.

A MODEL LAW FOR PROFESSIONAL

THE forthcoming edition of the Model Law for registration of professional engineers reflects 50 years of development. In the beginning, licensure was based on experience and education alone, with few, if any, examinations. Now there are examinations, and the pendulum has swung toward stiffer tests, longer experience requirements, and the inevitable elimination of "grandfather clauses."[2]

The first registration law was passed by the Wyoming legislature in 1907. Four years later, ASCE drafted the forerunner of our present Model Law called "An Act to Provide for the Licensing of Civil Engineers." Then, in 1915, a joint Committee of six national engineering societies prepared a new draft of this model law.

For a period of almost 20 years, the ASCE was a major and frequently the only contributor to the development of the Model Law. Their 1929 edition sparked the beginning of 30 years of co-operative effort by the entire profession.

The 1929 draft, called "Recommended Uniform Registration Law for Professional Engineers and Land Surveyors," was studied at a series of conferences by three Founder Societies, ASME, ASCE, and AIEE, the National Council of State Boards of Engineering Examiners, and also the American Association of Engineers and American Railway Engineering Association. These conferences continued through 1930 and 1931. By this time, AIME, AICE, as well as six state or regional societies had joined the group. The Model Law which resulted was placed before all interested local, state, and national societies for study and report. Meetings were held once again in 1932, and the Model Law produced was endorsed or approved by two Founder Societies, ASME and ASCE, as well as by ten other groups of local or national scope.

The edition now in use by the profession was published in 1946, and has been approved or endorsed by 13 societies of national scope including, for the first time, all five Founder Societies.

The 1960 Edition

The 1960 edition will incorporate these changes:

The length of the examination required of the engineering graduate has been increased to 16 hours.

The nongraduate must offer 12 years of experience and pass a 16-hour examination.

The candidate offering long-established practice as a basis for licensure must have at least 20 years of experience, be 45 years of age, and pass an 8-hour examination.

Thus the grandfather clause is nonexistent and there is no group exempt from a written examination. However, there is now included for the first time a provision which permits one board to recognize for credit the examinations given by another board. The intent here is to eliminate needless and repetitious examination of a candidate. Along these lines, and also for the first time, there is a clause designed to give official recognition to

[1] Chairman (1959) of the ASME Engineers Registration Committee; N. E. Manager, Air Preheater Corporation, New York, N. Y.

[2] Clauses which permit anyone already established in a profession to continue, though he be unable to meet the new requirements.

A Word to the New Graduate

In many states, the newly graduated engineering student has an opportunity to take part of his state examinations immediately, while his college training is fresh. He wins "Engineer-in-Training" certification. There remains "Qualifying Experience," and then he's a licensed engineer.

The following advice to new graduates is from a previous article on professional registration (Mechanical Engineering, April, 1958, p. 72).

The Engineer-in-Training movement is only 20 years old and is now in effect in some form in 36 of the states. In these states, and in some others which also require a written exam of all candidates for registration, the graduates of ap-

By W. H. Larkin[1]
Director, ASME

ENGINEERS

the Certificate of Qualification issued by the National Bureau of Engineering Registration.

Corporate Organization

The practice of engineering through the corporate form of organization is a widely accepted modus operandi and is in accordance with the stated policy of ASME. This point, as presented to the Annual Meeting of NCSBEE in Roanoke, Va., August, 1959, is as follows:

Section 22, Form of Organization for Engineering Practice: "Professional Engineers may engage in the practice of engineering in this State for or associated with a firm, partnership, corporation, or joint stock association, provided each individual professional engineer assumes his full responsibility for all work under his direction, and provided he is legally registered in this State, etc."

Point of Debate

This section is straightforward; its intent is clear. Yet before final action is taken on this revised Model Law, this one section is expected to evoke more discussion than all the other 23 sections. It is hoped that results will be realistic and constructive.

The present program to revise the Model Law contemplates the adoption of a final form at the next annual meeting of the National Council in Portland, Ore., in August, 1960. This revised edition will then be sent to all participating organizations for adoption or endorsement. Thus will be concluded one more chapter in the saga of the Model Law.

The ASME Policy

The Council of ASME, on April 6, 1956, adopted the policy which endorses and supports the registration of professional engineers as being in the best interests of the engineering profession and the general public. In support of this policy, ASME:

1 Approves in principle the Model Law and pledges to co-operate with other sponsoring groups in its revision, subject to approval by the Council.

2 Offers its facilities to assist in the appropriate revision or modification of registration acts in States where responsible organizations request such assistance.

3 Supports financially the activities of the National Council of State Boards of Engineering Examiners and gives advice and assistance to the Council when requested.

4 Recommends that there be no discrimination by implication, omission, or direction as to the form of business organization (individuals, partnerships, corporations, or others) under which the practice of engineering is conducted provided that the person or persons in responsible charge of such practice be legally registered professional engineers.

5 Recommends that each Section appoint a standing committee known as the Registration Committee to co-operate with the State Registration Board and the Section Program Committee in the dissemination of information concerning registration.

6 Recommends that each Section devote some time in a Section Meeting each year to the subject of engineering registration where, if possible, a member of the State Registration Board would address them.

7 Recommends that, in states in which written examinations are required of applicants for registration, Sections co-operate with other groups in sponsoring refresher courses.

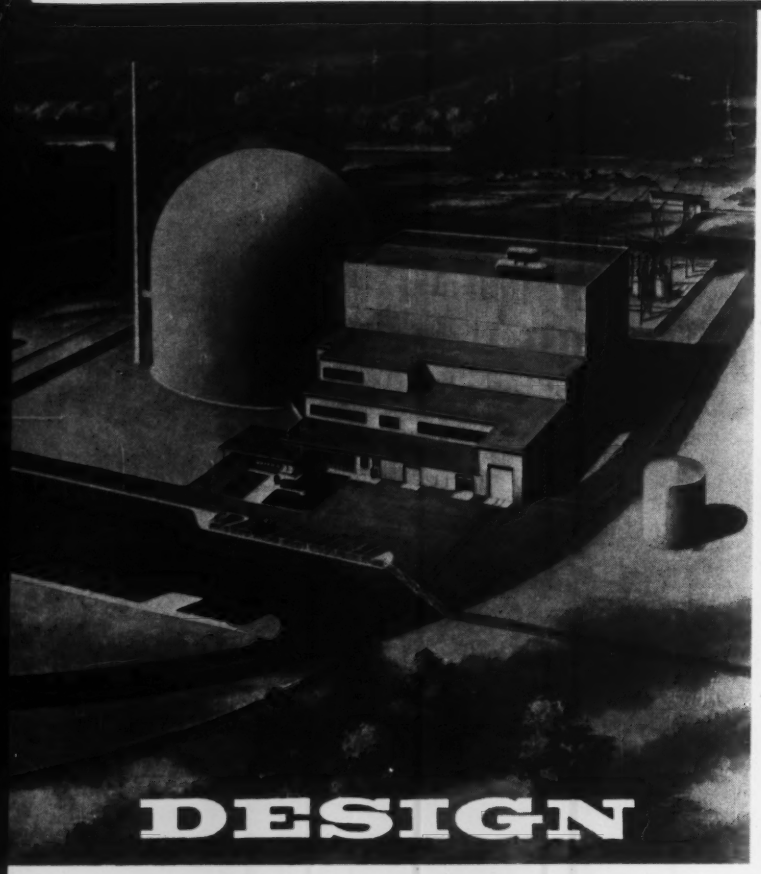
8 Recommends that each Student Section devote a session to engineering registration where, if possible, a member of the State Registration Board or a prominent registered professional engineer would address them, placing special emphasis on the purpose of registration, the standards required for registration, the Engineer-in-Training program, and the procedure for applying for registration.

proved colleges of engineering may write the fundamental parts of the examinations as soon as requirements for the degree have been met.

The professional registration boards, as well as the National Council of State Boards, are doing everything in their power to see that new graduates in engineering are given the opportunity to obtain their licenses. These boards do not have the opportunity of reaching many students who should be advised in this matter . . . It is a sad fact that many engineering graduates are leaving their college campuses without knowledge that a license is necessary to practice.

Once the young engineer has won his "Engineer-in-Training" certificate, he should be careful in his selection of employment to see to it that he gains qualifying experience. The several states differ in their exact requirements. The Model Law is a good general measuring stick.

Do not accept the opinions of those only casually acquainted with the law. The most satisfactory way of securing up-to-the-minute information is to get a copy from the State Registration Board. The Secretary of the National Council of State Boards of Engineering Examiners (NCSBEE), P. O. Drawer 1404, Columbia, S.C., can supply the address of any of the member state boards.



DESIGN

STUDY of a 300-mw Organic-Cooled Reactor

By R. Balent,[1] G. H. Bosworth,[2] and J. Plawchan[3]

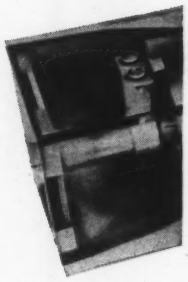
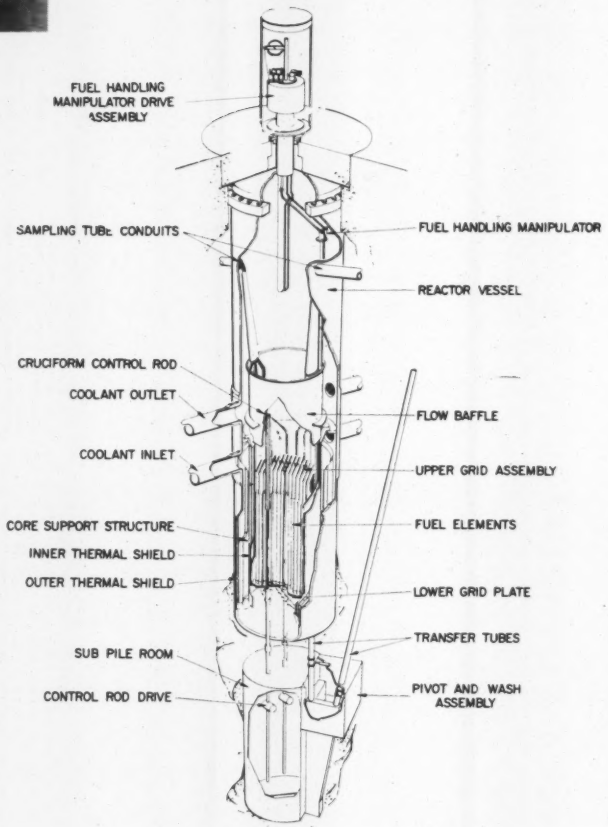


Fig. 1 The reactor building for the 300-emw OMCR plant is a 164-ft-diam cylinder with a hemispherical dome and an ellipsoidal bottom

Fig. 2 The reactor vessel is a 13-ft-8-in-ID, 61-ft-high cylindrical vessel designed for 100 psig at 750 F. Active fuel-element positions occupy 310 locations on a square lattice in the core with the remaining locations occupied by 20 dummy elements and 2 neutron sources.



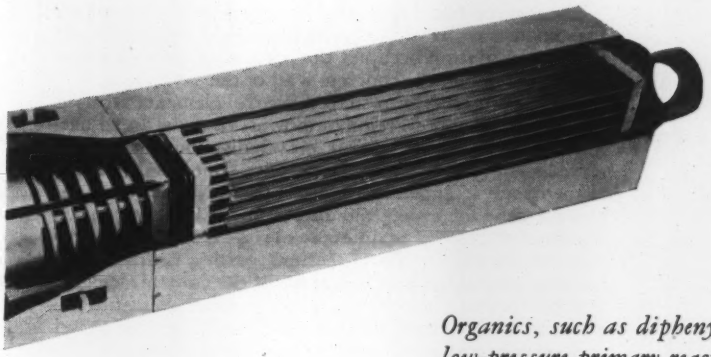


Fig. 3 A shortened prototype fuel-element model consists of 100 vertical fuel rods assembled in a 15-ft-long "spacemetal" box. The UO_2 pellets are 0.3 in. in diam. The cladding tube is made of luminum powdered metal.

Organics, such as diphenyls and terphenyls, permit high-temperature, low-pressure primary reactor cooling systems—plus reactor safety

One of the first basic patents in the nuclear field [1][4] suggested the use of organic materials as reactor coolants or moderators, but the radiation effects on organic fluids were erroneously thought to be extreme, and the need for enriched fuel retarded early work.

Design studies have shown that organic-cooled-and-moderated reactors for power application would have attractive features: (*a*) Low pressure on the primary system for temperatures in the 600 to 800-F range; (*b*) compact core; (*c*) no hazardous reactions with coolant, uranium, fuel, or water; (*d*) negligible corrosion rates; (*e*) standard materials and components (aluminum for fuel cladding, low-carbon steels in standard pipes and valves); (*f*) low induced activity in coolant; (*g*) fluid moderator-coolant gives large negative temperature and void coefficient of reactivity.

An organic-moderated-and-cooled reactor could be of simple design, relatively inexpensive to construct, and inherently safe. Yet certain limitations are recognized. Organics slowly change at operating temperature and under nuclear irradiation, so that a purification system and make-up supply is required. Heat transfer is relatively low, compared with water and liquid metals, so that a high surface-to-volume fuel-element design is needed.

The nongenerating Organic Moderated Reactor Experiment, OMRE, designed, constructed, and operated by Atomics International at the National Reactor Testing Station in Idaho, had operated more than 27 million thermal kwhr by August 1, 1959. OMRE operation showed negligible fouling of the heat-transfer surface and indicated a make-up cost in the range of 0.6 to 0.7 mills per kwhr at present organic market prices where used for both coolant and moderator.

Since organics are chemically compatible with uranium metal and uranium oxide, the form of uranium fuel can be chosen on purely economic grounds. Different types will be better suited for different applications. Analytical studies show that organic reactors can operate on the natural-uranium plutonium-recycle fuel program. Fuel development is a continuous process and the simplicity and chemical compatibility of the organic-reactor concept make it unusually simple to apply the best technology available at any time.

The use of organic reactors in central-station power plants is currently receiving attention and the Atomic Energy Commission recently approved a contract for the final design and construction of a small organic plant for the production of 11.4 net emw for the city of Piqua, Ohio. This plant and the preliminary design for a 150-emw plant have been previously described [2].

Recently the Atomic Energy Commission sponsored a study by the Bechtel Corporation and Atomics International for a large, optimized, organic-cooled reactor plant which is described in the balance of this paper [3].

Selection of Reactor Type and Capacity

The moderator material for this large organic-cooled reactor must lead to the highest over-all performance. Included in the evaluation were beryllium, beryllium oxide, zirconium hydride, heavy water, light water, graphite, and organic fluid. The organic-moderated-and-cooled reactor system, OMCR, showed the lowest total power cost and required the least developmental effort of the concepts examined.

Optimizing the OMCR power-plant design for low-cost power generation leads logically to the selection of a large unit. There are significant direct-cost benefits in the utilization of large-size plant components, and construction and operating costs can be distributed over a larger output. A survey of the turbine industry which indicated that a 300-mw turbine generator would be the maximum-size single-shaft machine likely to be available with present or near-future technology,[5] and a parallel survey of the power industry which indicated that 300-emw units are in the size range expected to constitute a significant fraction of new thermal-power capacity, led to the selection of 300 mw as the nominal unit rating for a large OMCR plant. It was recognized that some additional reduction in the cost of power generation could be obtained with a larger reactor unit supporting twin turbine-generators.

[1] Deputy Director of Organic Reactors Department, Atomics International, Canoga Park, Calif. Assoc. Mem. ASME.
[2] Supervising Engineer, Bechtel Corporation, San Francisco, Calif.
[3] Nuclear Engineer, Bechtel Corporation.
[4] Numbers in brackets designate References at end of paper.
Contributed by the Nuclear Engineering Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of The American Society of Mechanical Engineers. Paper No. 59—A-178.

[5] For the exhaust-end moisture resulting rom the steam conditions at the throttle.

DESIGN STUDY of a 300-mw Organic-Cooled Reactor

300-mw OMCR Plant

The reactor building is a 164-ft-diam cylinder with a hemispherical dome and an ellipsoidal bottom head, Fig. 1. This structure encloses the reactor, primary-coolant loops, steam generators, and fuel-storage facilities, providing a low-pressure containment barrier to prevent any uncontrolled release of radioactivity to the environment. Power-generating facilities, a central control room, offices, shop, warehouse, and personnel facilities are located in the turbine building. All coolant auxiliary equipment is located inside the reactor building. The building ventilation system is through the high stack.

Reactor. The reactor has a design capability of 934 tmw, and is cooled by a terphenyl mixture[6] having a bulk temperature of 675 F at the reactor outlets. The design-load coolant flow is 50,500,000 lb per hr with a 550-F reactor inlet.

Nucleate boiling (subcooled nucleate boiling), the principal heat-transfer mechanism in the hot channels, is accomplished by setting the primary system operating pressure so that the saturation temperature at this pressure is below fuel-element-surface but above coolant-bulk temperature. Thus nucleation will occur on the fuel-element surface, but the bubbles collapse as they are swept into the main body of the coolant.

With nucleate boiling, heat flux is independent of coolant velocity and about proportional to the cube of the difference between fuel-surface temperature and coolant saturation temperature. Thus the core can operate at heat fluxes comparable with the fluxes of cores utilizing forced convection, but with reduced coolant velocity. This permits a large coolant-temperature rise across the core (125 F) with a total flow about half that required in a forced-convection-cooled, close-packed-lattice core. Total pumping power is low and system operating pressure only 52 psia.

The reactor vessel for the 300-mw OMCR is unclad and fabricated of low-alloy steel, Fig. 2. It is a 61-ft-high cylindrical vessel with a welded dished head at the bottom and a removable dished head at the top. The tank has an ID of 13 ft 8 in. with a wall thickness of $1^1/_2$ in. The vessel is designed for 100 psig at 750 F.

There are 332 fuel-element positions on a square lattice in the core. Active fuel elements occupy 310 locations with the remaining 22 occupied by 20 dummy elements and 2 neutron sources. The core is surrounded by a steel inner thermal shield, a core-supporting structure, and an outer thermal shield. Steel grid plates are used below and above the core with the upper grid containing the necessary provisions for routing in-core instrumentation thermocouple and tubing lines.

[6] Coolant composition (during operation): <1 per cent diphenyl, ~70 per cent terphenyl isomers, ~30 per cent high boilers. Original coolant or new feed material (prior to exposure to operating reactor conditions) is composed of <1 per cent diphenyl, 7–14 per cent ortho-terphenyl, 47–62 per cent metaterphenyl, 17–40 per cent paraterphenyl, <1 per cent high boiler.

The reactor vessel is located within a cavity formed by the concrete walls of the biological shield. Commercial thermal insulation occupies the remaining space between the core tank and the concrete wall of the cavity.

Fifty-seven cruciform-shaped control elements are used in the reactor core to regulate power, to assist in adjusting the radial and axial core power distribution, and to serve as safety rods for any emergency shutdown. These elements are arranged in a pattern that provides one control element for every four fuel elements in the control region of the core. Stainless steel is used as the cladding material for the cruciform sections, with a neutron—absorbing material of Eu_2O_3 in some of the control elements and boron steel in others. These control elements are actuated from the sub-pile room below the reactor vessel and are removed or replaced from above the core.

Fuel. The UO_2 fuel is enriched to 2.1 per cent U-235 and is clad with finned Aluminum Powdered Metal (APM)[7] tubing. Each fuel element, as shown in a shortened prototype model, Fig. 3, consists of 100 vertical fuel rods assembled in a long "spacemetal"[8] box measuring $5^1/_8$ in. on a side. The over-all length of the fuel-element assembly is approximately 15 ft; the length containing fuel within the assembly is approximately 12 ft. Each fuel rod is made of two sections 7 ft long, sealed by APM end plugs. The UO_2 pellets are 0.3 in. in diam. The fuel rods are spaced on 0.493-in. centers. The fins on the APM cladding tube are fabricated to have a slight helical pitch to prevent meshing and to insure proper spacing when assembled within the fuel-element box.

To achieve the most efficient fuel utilization it is necessary to obtain the maximum possible burnup for each fuel element in the reactor. With proper programming, it is possible to average 15,000 tmw days per metric ton of uranium based upon a fuel-loading schedule which makes use of three zones of fuel elements. During refueling periods the fuel is moved among zones with the new fuel loaded initially in the peripheral zone. The high-burnup fuel in the central region of the core assists in providing uniform radial power distribution.

Organic-Coolant System. Coolant circulated, in parallel, around three identical heat-transfer loops transfers heat from the reactor core to the steam, Fig. 4. Each loop consists of a circulating pump and a steam generator, complete with superheater and economizer. All pressure parts in the organic-coolant system, including piping and equipment components, are fabricated of carbon steel. Double-block valves are installed on the supply and return lines of each loop to insure tight shut-off and permit maintenance on one loop while the reactor is in service.

The circulating pumps are vertical-turbine type, each rated 38,000 gpm, using a 2000-hp-motor drive with a 30-sec emergency power provision in the case of station loss of power. A 30-hp pony motor is also provided, mounted integrally with the main pump motor, and fed from the emergency power system, to provide sufficient circulation for removal of afterglow heat from the reactor core.

The steam-generator units are made up of horizontal heat exchangers having U-tube bundles. The organic coolant is on the tube side of the steam generator and on the shell side of both the economizer and the superheater. At full load, the three units produce a total of 3,356,000

[7] Commercial product, 6 to 8 per cent Al_2O_3 plus aluminum.

[8] Stainless-steel honeycomb-sandwich material, equivalent to a solid 0.013-in. sheet.

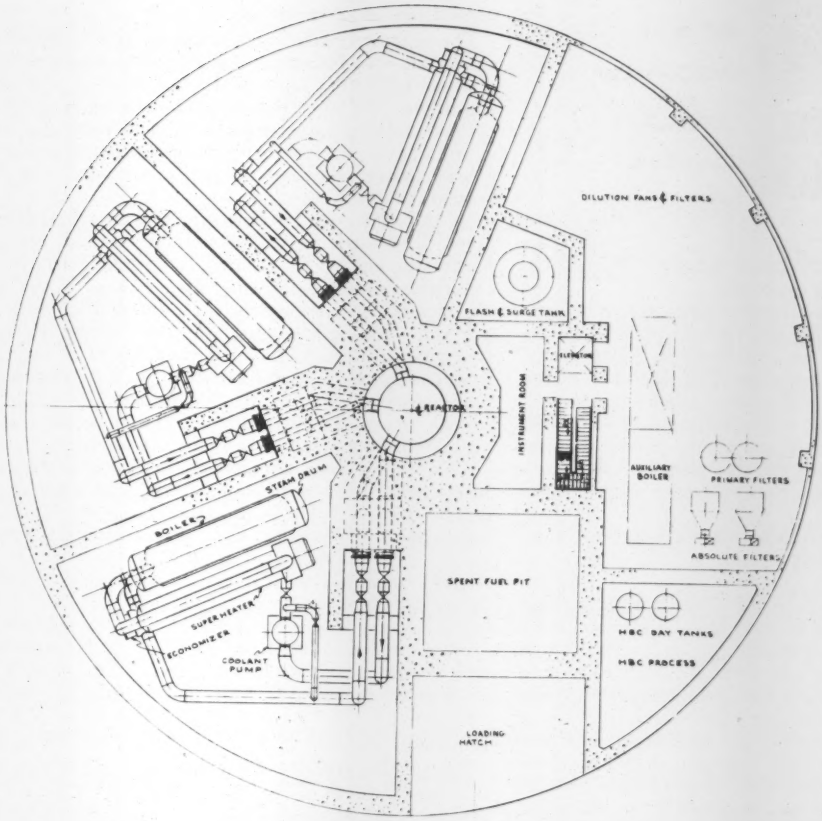


Fig. 4
Each of three identical heat-transfer loops, as seen in this reactor-building floor plan, consists of a circulating pump and a steam generator, complete with superheater and economizer. At full load, the three units produce a total of 3,3506,00 lb per hr of 600-psig 650-F steam.

lb of steam per hr at turbine throttle conditions of 600 psig, 650 F. The lower steam and heat requirements for less-than-full-load conditions are controlled by a bypass line around each steam-generator unit, returning a portion of the hotter coolant directly to the reactor. The resultant higher temperature of coolant entering the reactor automatically leads to an adjustment in the control rods to decrease reactor heat output and maintain the 675-F reactor-coolant-outlet temperature. In accordance with the ASME Boiler and Pressure Vessel Code, each steam-generator unit is provided with automatic safety valves. In addition, two power-operated relief valves are provided for each steam-generator unit, each capable of removing approximately 120 per cent of the unit design steam flow. Protection of primary-coolant-loop piping from overpressure due to a steam-generator tube failure is provided by a group of relief valves on the piping in each loop.

Small turbine-driven pumps furnish feedwater to the steam generators, taking suction from the condensate storage tank. The steam thus produced is used to drive the pumps, with any excess vented to atmosphere.

When passing through the reactor core, the coolant undergoes a small degree of radiolytic and pyrolytic change, necessitating the use of auxiliary equipment to dispose of the altered fractions. Water vapor, hydrogen, and light hydrocarbons are removed in the degasification system by continuously flashing a small side stream of the primary coolant to a tank under vacuum. A separate side stream passes through a single stage of fractionation in the purification system where high boilers, HB, are removed. This material is subsequently burned in the auxiliary boiler. Storage tanks of 106-day capacity allow any radioactive material removed with the HB to decay to a safe level prior to burning. Coolant make-up is maintained at approximately 22,000 lb per day during full-load operation to replace the high-boiler and gaseous material thus removed. The waste-gas handling system filters, holds up, dilutes, and exhausts through the ventilation stack (after fission products have been removed) all gases from the purification and degasification system.

Turbine-Generator Plant

The turbine-generator is a tandem-compound, double-flow, condensing 1800-rpm machine rated 300 mw at 3.5 in. Hg abs and 3 per cent make-up, with a guaranteed throttle flow of 3,356,000 lb per hr of 600 psig, 650-F steam. A turbine-exhaust pressure of 1.5 in. Hg abs is obtained with 57-F screened river water in the main condenser, and leads to a gross turbine heat rate of 10,146 Btu per kwhr with gross and net outputs of 314.4 and 301.1 mw, respectively. Turbine-exhaust steam, condensed in a single-pass divided-water-box condenser, is reused in the system. In the regenerative feedwater cycle, condensate is pumped through two low-pressure extraction-steam heaters to a deaerating heater. To complete the cycle, boiler feed pumps take suction from the deaerator, discharging through two high-pressure feedwater heaters into the steam generators at 394 F. The turbine-cycle make-up requirements are met by gener-

ating steam in the auxiliary boiler which is then introduced into the cycle at the deaerator.

The generator is of the totally enclosed, 1800-rpm, synchronous type rated 384,000 kva at 0.85 pf, 0.64 short-circuit ratio, generating at 13,500 volts. The stator windings terminate in 12 bushings, 6 on each end of the underside of the generator. The generator is cooled with 45-psig hydrogen and has a shaft-driven exciter with a motor-driven spare. For emergency-power requirements, two diesel generators provide power to the emergency bus which also feeds a battery system through two motor-generating sets.

Auxiliary plant services include fire protection, compressed air, turbine lubricating oil, service water, and cooling water.

Because of the relatively high coolant temperature, initial steam conditions of at least 1250 psig at 660 F are attainable at the turbine throttle, provided some such scheme as steam reheat at the turbine crossover is used to limit exhaust-end moisture to a level compatible with present-day turbine technology. However, a thorough optimization study of steam-cycle variations indicated that no economic advantages resulted from reheat at attainable steam conditions. Standard throttle steam pressures higher than 600 psi resulted in an increased power cost due primarily to the greater steam-generator heat-transfer surfaces required at higher pressures, even though the advantageous properties of the organic coolant made possible relatively inexpensive surface.

Design Summary—300-mw OMCR Plant

Turbine Plant	
Turbine nameplate rating, mw at 3½ in. Hg	300
Electrical output, mw, 1½-in. Hg gross/net	314.4/300.0
Gross turbine heat rate, Btu/kwhr, 1½ in. Hg	10,146
Net plant heat rate, Btu/kwh, 1½ in. Hg	10,534
Type/speed, rpm	TCDF/1800
Guaranteed throttle flow, lb per hr	3.356×10^6
Throttle steam conditions, psig/FFT	600/650
Condenser, single-passage flow, gpm	single/203,000
Generator, kva/kv	384,000/13,800
Exciter, rpm/type	1800 rpm/motor
Exciter, kw/volts	1800/375
Reactor, Steam Plant	
Full-load rating, tmw	934
Coolant temp, outlet, deg F	675
Coolant temp, inlet, deg F	550
Coolant flow, lb per hr	50.5×10^6
Number of primary loops	3
Fuel (atomic per cent U-235 in UO_2)	2.5
Number of fuel elements	310
Number of fuel control rods	57
Conversion ratio, initial	0.69
Average burnup, (tmwd/mt)	15,000
Active core diameter, ft	10.33
Active core height, ft	12
Peak/average power ratio, initial	2.55
Peak/average power ratio, final	3.77
Average specific power, (kw/kg)	20
Maximum temperature, UO_2 center, deg F	4000
Maximum temperature, cladding surface, deg F	850
Maximum heat flux, Btu/ft² hr	133,300
Steam generator and superheaters	U-tube
Rating, (lb per hr) at turbine throttle conditions	3.365×10^6
Reactor building diameter, ft	164

Control and Instrumentation

The reactor control and instrumentation provides for automatic load-following control in the power range and nonload-following control during start-up and normal shutdown. It also functions as the plant protective system providing automatic action to minimize or prevent damage as a result of mis-operation or malfunction of equipment. A diagram of the reactor plant-control system is shown in Fig. 5.

In automatic load following, system frequency regulates the throttle valve and voltage controls excitation. Feedwater control is insured by a conventional three-element controller. Steam pressure ahead of the turbine throttle is used to control the flow of coolant bypassing the steam generators, thereby setting the rate of steam generation. The bulk temperature of the coolant from the reactor is used to control reactor power by automatic positioning of control elements. Up to 20 per cent of the steam flow to the turbine can be manually bypassed to the condenser to facilitate start-up.

The reactor core is provided with neutron-detecting instruments to record the flux level and optimize power distribution. An in-core power-mapping system determines flux distributions in the core during reactor operation. This information assists the operator in maintaining optimum control-rod positions and determining integrated fuel burnups throughout the core. If the gross activity level in the primary circulating system exceeds a predetermined level, a failed-fuel-element detection system can be employed to locate the specific element or elements causing the high radiation levels.

Economics

The total capital investment required for final design and construction of the first 300-mw OMCR unit as the design is presently conceived is estimated at $62,420,000, or $207 per net kw electrical. This sum includes contingency, escalation, and interest on construction based on a project schedule leading to plant operation in December, 1963. For purposes of comparison, present-day cost which does not include escalation or interest on construction, amounts to $164 per net kw.

The low cost attained for the present design arises in considerable measure from the low vapor pressure of the organic coolant at elevated operating temperature and its chemical inertness which eliminates corrosion as a significant consideration in the selection of reactor-system materials. Consequently, relatively low operating pressures and low carbon-steel structural materials are used in the reactor loop. The APM-clad UO_2 fuel contributes neutron economy, long fuel endurance, and attractive first cost to the fuel cycle. A structurally simple mechanical design is possible for the single-fluid moderator-and-coolant reactor concept, and the fluid's good neutron-moderating properties permit a compact core and lower costs in structures and shielding. The most economical combination of reactor steam-cycle containment parameters for the power-plant system was fixed at the supplementary design stage.

Fuel-cycle costs for the equilibrium state, attained after the first core is spent and replaced, are estimated at 2.23 mills per net kwhr electrical when initial fuel-fabrication costs are applied. Reasonable expectations of economies in fuel fabrication during the first five years of plant operation, amounting to about 40 per cent of initial rates, lead to 1.92 mills per net kwhr as a more representative figure over the expected plant life.

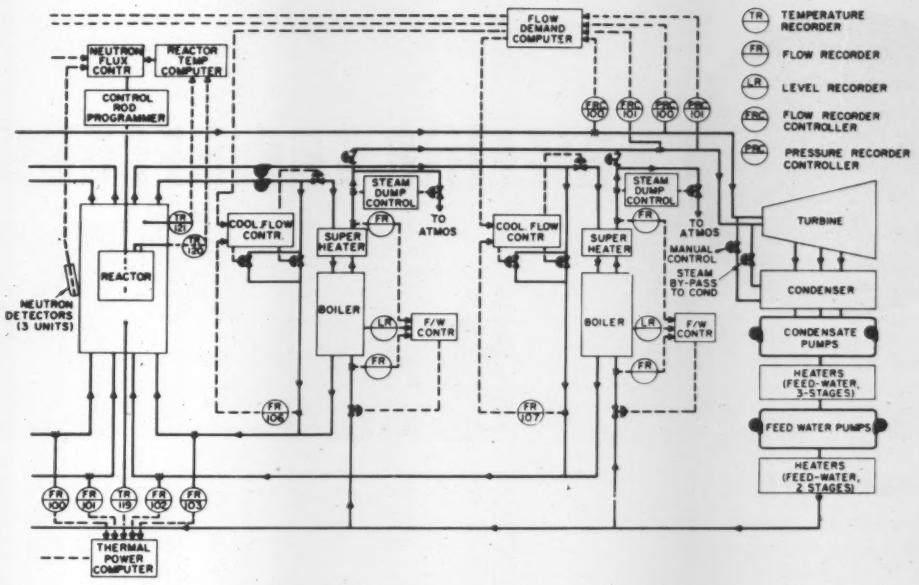


Fig. 5 Reactor control and instrumentation provide for load following in the power range and nonload following control during start-up and normal shutdown

A fixed-charge power cost of 4.14 mills per net kwhr for the 301.3-net-emw capacity is determined by applying a 14 per cent annual charge on total capital investment at a plant-capacity factor of 80 per cent. The 0.94 mills per net kwhr derived for operation and maintenance charges provides for the coolant make-up at the current market price of 17¢ per lb, plant operating and maintenance staff, and other costs. The net power cost therefore is predicted to be 7.31 mills per net kwhr for the fuel cycle including initial fuel-fabrication costs, and 7.00 mills per net kwhr for the anticipated reduced fuel cost.

Future improvements in the power cost attainable, not included above, may result from: (*a*) Design economies prior to construction, (*b*) any reduction in the 17¢ per lb price for organic coolant which might result from quantity demand, (*c*) any other measures inhibiting coolant change under reactor conditions such as chemical additives, or process parameter control, and (*d*) an extension of fuel lifetime beyond the 15,000 mw days per ton now foreseen, perhaps to as much as 20,000 mw days per ton. Although such savings cannot be assured in their entirety, they might result in a further reduction of up to 0.5 mills per net kwhr in generating power cost over an important fraction of the plant lifetime, leading to an expected range of 6.5 to 7.0 mills per net kwhr as applicable to the current plant design.

Forced-Convection Core-Cooling Design. A comparative preliminary design and cost estimate of a core system which permitted no nucleate boiling determined that the effect of this change in design basis on total capital investment required was insignificant, although higher pumping costs and fuel inventory combined to increase predicted net power-generation cost by about 0.5 mills per net kwhr. Core and fuel-element optimization resulting from the removal of arbitrary limits on the forced-convection core design can be expected to reduce the margin of power cost above the nucleate-boiling version to the 0.2 to 0.3 mills per kwhr vicinity.

It is considered rather remarkable that a detailed comparison of the comparable cost estimates for the coal-fired and OMCR units indicates direct construction costs for the two types of plant to be virtually equal. All the difference in capital investment ($165 versus $207 per net kw) can be attributed to what might be termed "first-time" costs. These are contingencies, initial start-up costs, and increased escalation and interest on construction resulting from the somewhat longer construction and start-up schedule. It appears to be an inescapable conclusion that one or more projects which would round out the experience and technology of large OMCR units would be an important step in closing the remaining gap between OMCR and conventional-power cost.

References

1 E. Fermi and L. Szilard, "Neutronic Reactor," Patent no. 2,708,-656 filed December 19, 1944; issued May 17, 1955.

2 E. E. Parkins and E. F. Weisner, "Organic-Moderated Reactors for Central-Station Power," *Trans. AIEE*, vol. 40, January, 1959, p. 985.

3 "Organic-Cooled Power-Reactor Study," TID-8501 (6 parts), 1959, U. S. Atomic Energy Commission.

Comparison With 305-mw Coal-Fired Plant

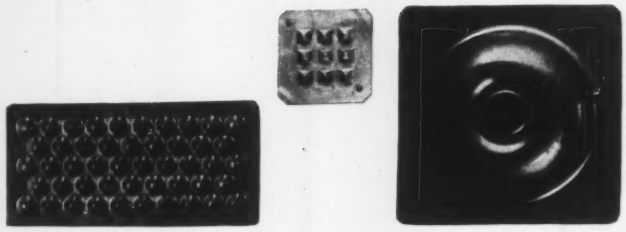
	Mills per net kwhr	
	305-mw coal-fired	300-mw OMCR
Fixed charges	3.30	4.14
Fuel cost	3.25[a]	2.23
Coolant make-up	—	0.60
Operating and maintenance	0.22	0.34
Total	6.77	7.31
Possible future conditions	7.24[b]	6.5–7.0[c]

[a] Coal at 35 cents per million Btu.
[b] Coal at 40 cents per million Btu.
[c] As discussed in previous section.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD



Explosively formed products

Explosive Forming of Metals

ALTHOUGH British and German engineers were awarded patents on explosive-forming processes as far back as 1900, little was done until 1954 or 1955 to perfect the original work.

According to an article in the *Welding Engineer* for April, 1959, and a paper published under company auspices by Vasil Philipchuk, manager, test and evaluation department, National Northern Division of American Potash & Chemical Corporation, West Hanover, Mass., explosive welding or forming will handle jobs that can't be done by any known conventional means.

The Nature of the Process. In explosive forming there is initially "a rapid movement of metal through its elastic range and into the plastic range, producing permanent set or shape within microseconds," according to Philipchuk. This unbelievably high rate of stress application is the essential difference between explosive metal forming and conventional forming. Initial stress loads are considerably greater with explosive forming. Whereas the highest stress is applied instantaneously with explosives, under mechanical methods the stress increases gradually.

Other advantages are: (*a*) Only one die is needed for welding or forming by means of high-explosive charges; (*b*) extremely close tolerances can be held; (*c*) there is no spring-back—a part subjected to an explosive charge for forming remains exactly as the die shapes it; (*d*) physical characteristics are improved—although there is some difference of opinion on this point, National Northern is confident from the results of the experiments that metal is work-hardened by the blast.

Direct Function of a Mechanical Property. Evaluation of the data obtained from National Northern's explosive-forming program indicates that the ability of a metal to be formed by explosives is a direct function of a mechanical property—per cent elongation. Other parameters which enter into the relationship are the maximum amount of plasticity available through explosive forces; the temperature of the metal; the medium used for force transmission; the type, amount, and shape of the explosive charge; and K_m—the constant for a particular family of metals determined through experimental tests.

The K_m constants obtained thus far for various groups of metals and their alloys, under convenient test conditions, follow.

A K_m greater than 1.0 indicates that explosive forming has occurred to a degree that much greater than the conventional per cent elongation.

Metal or Alloy	K_m
Nickel	1.0
Stainless steel	1.1
Titanium	1.5
Plain carbon steels	2.3
Aluminum	2.5

The constants were obtained with explosive A where the medium was water and the temperature was ambient. An explosive charge placed in water—or in some other medium that will transmit the force of the blast (for example, talc, clay, plastic, or oil) can be 10 times smaller than a charge used in the open air to do the same job. Cast steel can be the most commonly used die material—although concrete and plastic have been employed on occasion.

Explosive Forging and Welding. The feasibility of explosive forging has also been investigated. The techniques vary, but the same process of high-rate stress application is used. Preliminary forgings have been made of wheels, turbine-rotor shapes, and connectors. These have been forged both cold and hot with aluminum alloys. Forgings which are impossible or very expensive by conventional methods are to be emphasized in the continuing studies.

Apparently any similar or dissimilar materials can be welded, although the technique for each group is different and needs to be determined. Surface-to-surface bonding without any actual fusion of metal can also be done. Aluminum has been bonded to steel and steel to steel in tubular shapes where a watertight bond was required. Bonding of plate to plate and other variations are under investigation.

The design and handling of an explosive charge are critical since a properly designed explosive charge the size of a pencil eraser can be fatal to a human being standing 5 to 10 ft from the point of detonation. However, explosives are as safe as any other material if designed and handled by qualified personnel, the Philipchuk report concludes.

The production-engineering department of Lockheed Aircraft Corporation is also interested in explosive forming. It is performing work under a Manufacturing Methods Branch, Air Materiel Command contract to

select an optimum method and to determine the quality of the product. A method of focusing the shock has been developed for use where the explosive is suspended in air. Water has also been used as a transfer medium and both Kirksite and plastic dies have been used satisfactorily. Work is continuing, although several interim reports have been issued.

Types of Explosives. According to an unpublished manuscript on explosive forming, received through the courtesy of John S. Rinehart, director, Mining Research Laboratory, Colorado School of Mines, there are two main types of explosives. These are high explosives, which are characterized by very high rates of reaction and high pressure; and deflagrating explosives or propellants which burn more slowly and develop much lower pressures. The energy released on reaction in either case is usually about 1000 calories per gram of explosive. With high explosives the pressure may be as much as 4,000,000 psi at the surface of the explosive. A short distance from the explosive, the pressure is much less but its duration is longer.

Propellants burned in the open produce pressures no higher than a burning match, but they can be confined to produce controllable pressures as high as 40,000 to 50,000 psi.

Place of Detonation. The diverse applications of explosives to metal forming, Professor Rinehart continues, group into those situations in which the explosive is detonated in intimate contact with the metal to be reworked or formed, such as in the hardening of steels, the compaction of metal powders, the splitting of ingots, and cutting operations; and those in which objects such as cups, rocket nozzles, missile nose, and aircraft parts are sized or formed by drawing, using propellants or explosives detonated in air or water at some distance from the worked piece.

When the explosive is placed in intimate contact with a metal and detonated, the stresses just inside the metal will instantaneously become exceedingly high, and a transient stress disturbance is set up which is transmitted through the metal, producing fracture, plastic flow, and other deformations, the exact nature of which will be strongly dependent upon the configuration of the metal-explosive system. Even under these extreme pressure conditions, the metal is seldom converted to a fluid, exhibiting in general the properties of a quasi-elastic brittle material.

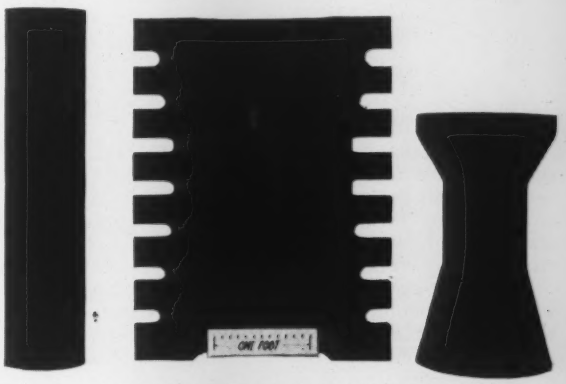
The stress, being intense enough to distort and break up the crystalline grains of the metal, work-hardens the metal, in some cases to a depth of a half inch. Manganese or Hadfield steel, notorious both for its resistance to abrasion and work-hardening, is now being successfully work-hardened by the detonation of thin layers of sheet explosive placed on the surface, thereby greatly increasing its abrasive resistance.

Generally, in explosive forming, the explosive is not placed in intimate contact with the metal but is separated from the workpiece by water or some other fluid.

In conventional metal forming, the metal of the part that is to be formed must, at some time during the forming operation, be in contact with the forming die. The distribution of stress established by the die is exceedingly complex, almost impossible to describe, with many opportunities for the development of regions of high stress concentration which, in turn, can lead to fracturing in localized areas. A dynamic stress field of the kind set up when an explosive is detonated in a liquid usually distributes itself more uniformly over the whole piece to be formed, penetrating into every crack, crevice, and corner so that the metal is pushed about uniformly. In effect, it is almost as if one were using a well-lubricated die of ever-changing shape, the shape continuously and instantaneously conforming to the shape of the metal part as it is being formed.

Example of Explosive-Forming Operation. A typical explosive-forming operation such as the sizing of a metal nose cone, 5 to 6 ft in diam, 1 in. thick, might be carried out as follows, Professor Rinehart states. The partially formed nose cone, dimensionally within several thousandths of final tolerance, would be placed in a large female die. The cone would then be filled with water and one or more explosive charges, perhaps an ounce each, would be suspended in the water at appropriate locations, the charges then being detonated electrically from afar. The charges explode, pushing the water ahead of them against the metal, the metal drawing itself out so as to fill the die completely. In other cases, water is placed in a polyethylene bag, with female dies sometimes being used, but in other instances the metal is allowed to form itself freely, taking whatever shape the pressure of the pulse dictates. The movement of the metal is not particularly rapid, being at most 100 to 200 fps, a velocity below the critical impact velocity of most metals.

Conclusions. Professor Rinehart cautions that, in spite of much propaganda to the contrary, metals as a rule have less ductility when deformed rapidly than when deformed slowly. A few metals, notably the high-manganese and high-nickel steel alloys, manifest increased ductility when strained rapidly. There is a paucity of data on the effect of rate of straining on the ductility of metals, but the physical properties of metals at low temperatures have been intensively investigated and many analogies can be drawn, both behavior patterns being dependent upon activation energies in much the same way.



Left to right, raw stock, die, and finished part of an explosively formed rocket nozzle

Metal forming using explosive charges is in its infancy, but its potential is now being evaluated with great intensity. It is still too early, Professor Rinehart concludes, to make a realistic appraisal of the engineering potentialities of these new and scientifically fascinating modes of processing metals.

Appreciation should be expressed to Emery B. Kerekes, Mem. ASME, of Arthur D. Little, Inc., for supplying information on the places where explosive-forming research is being undertaken.

Above, a compact controller regulates the speed and reverses the experimental tractor

Right, a mixture of fuel gases—largely propane—and oxygen react in an electrolyte to provide the electricity which powers a 20-hp motor

Fuel-Cell Tractor

A FUEL-CELL-POWERED tractor has been demonstrated by Allis-Chalmers Manufacturing Company. The vehicle, still in the research stage, develops at least 3000 lb of drawbar pull, enough for the 5270-lb tractor to tow a multiple-bottom plow.

The electricity comes from 1008 individual $^1/_4$-in-thick by 12-in-sq fuel cells which are joined in 112 units of nine cells each. The 112 units are arranged in four banks and electricity can be taken from any combination of banks.

A mixture of gases—largely propane—fuels the cells by reacting in an electrolyte. The total electrical output is 15 kw.

The chemical reactions within the cells cause a direct current to flow through an external circuit which is connected by bus bar to a standard 8 × 11 × 21-in. controller. This regulates the electricity supplied to a standard 20-hp d-c motor made at Allis-Chalmers Norwood (Ohio) Works.

Speed may be regulated, or the tractor's direction reversed, by moving two levers. Using the speed control, the operator places the four banks of cells in series or parallel, varying the amount of current going to the motor.

To reverse the tractor, the driver moves the second lever, changing the polarity of the current flow to the motor.

The tractor carries its gas supply in tanks mounted in brackets on the vehicle.

Allis-Chalmers Research Division developed the prototype fuel cell a little more than a year ago. Since then, a team of about 20 engineering scientists in the research laboratories built the larger version installed in the modified Allis-Chalmers D-12 tractor.

Magnetic Flowmeters

IN THE next five years, magnetic flowmeters will take over a significant portion of the applications now held by differential-pressure units and displacement meters, according to *Chemical and Engineering News*, October 5, 1959.

The total flow-measurement market will increase considerably—possibly even by 25 per cent—as processors apply magnetic meters to streams on which they have not been able to measure flow directly. Stated briefly, look for magnetic meters—which were introduced only a couple of years ago—to dominate some types of flow measurement in just a few more years.

Advantages. Magnetic flowmeters have four big advantages: (*a*) Accuracy—claimed to be within 1 per cent on most standard models, while better than 0.25 per cent can be realized on some special designs; (*b*) wide applicability—to streams with electrical conductivities down to the micromho-per-centimeter range and to streams containing solids; (*c*) reasonable cost—somewhere around $1000 for the primary element, with about that much more for recorder, controller, and other accessories; (*d*) unhindered flow pattern—since nothing protrudes into the stream, the instrument does not add pressure drop nor does it add any obstructions which could cause plugging.

How They Work. A magnetic flowmeter, according to *Chemical and Engineering News*, is the reverse of an electromagnetic pump. It works on the principle that a conductor (in this case, the process stream) moving through a magnetic field generates an electrical potential. This electromotive force is directly and linearly proportional to the rate at which the fluid is flowing. Other major variables are field strength and pipe diameter (which sets the distance between electrodes).

Improvements in meter design, some recently disclosed and some still in embyro, aim at getting more accuracy and more applicability with little or no increase in cost. Calibration is the key to accuracy; modifying stream proprtiees and electronic circuitry are the roads to wider usefulness.

The Developers. Fischer & Porter is now developing "dopes" (additives) for nonconductive streams such as hydrocarbons to raise their conductivity to a measurable level. The company says that it has a few under test now that can do this at very low concentrations—"an eyedropperful for thousands of gallons"—but is not ready to disclose the type of chemical.

The company admits readily that dopes won't handle

all possible process streams. Some can't tolerate even parts per million of adulterants. But there are other ways of getting at these streams, and the company is working on several. It expects to announce some of them within a year or so.

Foxboro, which also claims 1 per cent accuracy for its standard magnetic flowmeter, is working along somewhat different lines. It uses system variables of gap, field, and velocity for liquids with relatively high conductivities, where variations in stream composition and conductivity do not significantly affect accuracy. But when stream conductivity gets down to the 1 micromho-per-centimeter range, variations do affect the accuracy. For these streams, Foxboro is looking into ways to measure conductivity continuously and automatically compensate for changes in it. However, the company is not actively searching for dopes, a spokesman says.

Hays, on the other hand, claims its meter, which will go into production sometime this winter, will give $^1/_2$ per cent accuracy on streams with conductivity down as low as 0.05 micromho per centimeter. It says its circuit design is the reason for these high-performance figures. Another feature: A 60-cps signal frequency for compatibility with other a-c components.

Total market for primary-flow-measurement elements is about $20 million a year now. If the advantages of the magnetic meter which Foxboro and F & P (and now Hays) praise so highly prove out in practice, these meters will take over much of this market and create another of their own in many spots where flow is now either inferred from other measurements or left out of the control scheme altogether.

Spar-Broaching Machine

New broaching techniques developed at the Hudson, Mass., plant of The Lapointe Machine Tool Company have made possible such difficult tasks as broaching the inside contour of a 24-ft helicopter spar. Over 30 broaching tools were used from the initial roughing operation to the final pass which leaves a superfinish of better than 50 microin.

The broaches are handled by a special conveyer system designed by Lapointe, which places each broach in the current position at the entering end, and at the conclusion of the stroke the broach is returned to the conveyer, ready for use on the next spar.

The present machine, for the 24-ft spar, has a capacity of 50 hp and is 66 ft long. Built in three sections on the building-block principle, this will allow the broaching of a much longer spar by adding more sections.

Because of the extreme length of this broaching machine, it is equipped with a traveling platform, or "trolley," so the operator can ride on it and quickly move the entire length of the workpiece without fatigue. This traveling platform is electrically controlled and has automatic stops for complete safety, thus giving the operator complete control of the broaching operation at all times.

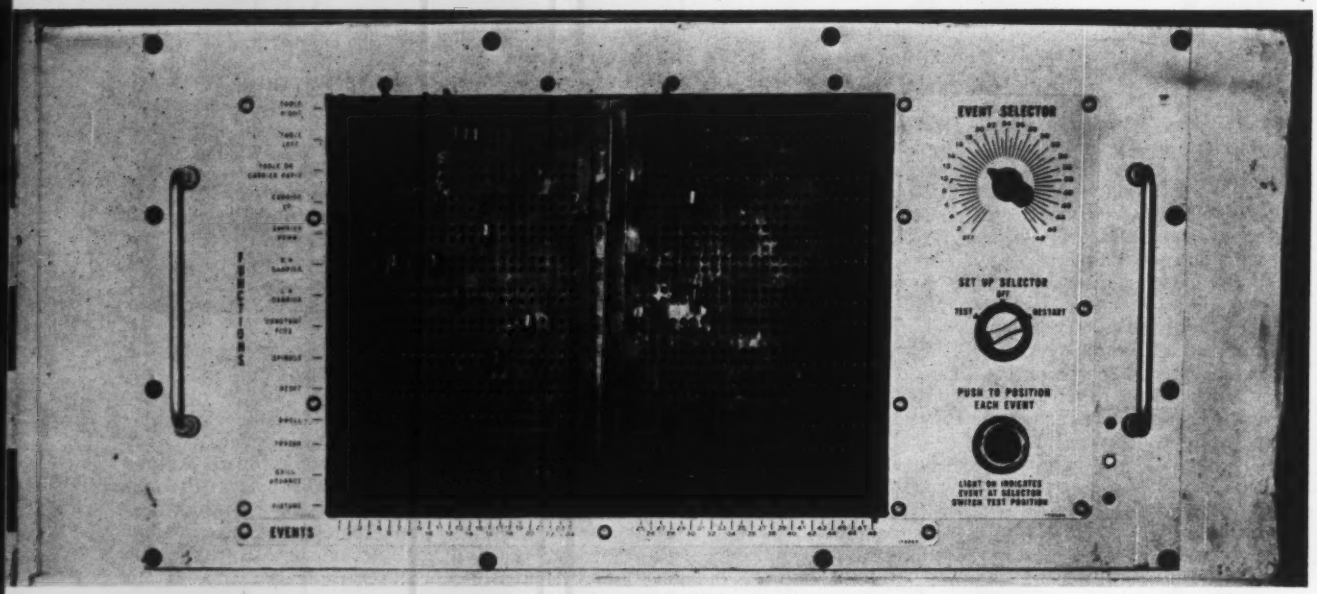
The electromechanical drive has been selected by the engineers at Lapointe to provide a steady pull and eliminate all possibility of chatter.

The workpiece is a hollow aluminum extrusion, furnished by The Aluminum Company of America. It is a tough 4153 aluminum alloy, the original blank weighing 700 lb. The blank is mechanically held in the machine by eight clamps, to insure maximum straightness of spar for broaching. After removing approximately $^1/_8$ in. of stock (or 80 lb) on internal surfaces, the spar is inspected by boroscope for the entire length, to ascertain if the surface finish is within the 50-microin. requirement.

Lapointe engineers state that this is the first time that it has been possible to produce a one-piece extruded blade to replace the conventional fabricated spar, and they claim that the broaching operation is essential to insure the elimination of imperfections in the surface of the extrusion. The hole is broached straight within ± 0.005 in. The uniform straightness eliminates many exterior machining operations and hand scraping, producing uniform thickness of the finished helicopter spar, after the external surface has been milled. Broaching also decreases the possibility of fatigue strains in the finished prop. The broaching operation has made it possible to produce all-metal spars of greatly increased service life.

Although at the present time a complete spar can be broached in $2^1/_2$ hr, floor-to-floor time, it is believed that this time will be improved with the gaining of experience in handling the new Lapointe machine.

The inside contour of a 24-ft helicopter spar can be broached on a single machine which uses 30 broaching tools. Rough machining to a final pass which leaves a superfinish of better than 50 microin. is done on the 66-ft-long machine which includes a trolley so the operator can move quickly along its length.



Up to 24 events involving the various machine functions in a complex milling-machine cycle can be programmed simply by inserting pegs opposite the machine function in the proper sequence. Templates can be prepared with holes for only those functions required for a specific job.

Telematic Control

TELEMATIC—a pegboard-type automatic milling-machine cycle control—has been introduced by the Cincinnati Milling Machine Company for use with their new 200 Series Hypowermatic Milling Machine. The panel controls all functions or movements of the machine and provides for such auxiliary operations as fixture clamping or indexing. For each machine function there is a row consisting of 24 holes allowing the operator to "peg in" complex automatic milling cycles involving up to 24 steps or events. If desired, pegboard panels having more than 24 events can be supplied.

Setup consists of inserting plugs in holes opposite the desired function in proper sequence. Trip dogs, positioned on machine table and spindle carrier, initiate each new action and Telematic control directs the action.

The machine functions that can be programmed are: Table right or left, table or carrier rapid, spindle carrier up or down, constant feed for accurate stop, dwell, quill advance, tracer control, spindle rotation, fixture control, and reset. A stepping switch scans the control board one step at a time and initiates all functions indicated by the placement of pegs.

When the relay scans "reset," it automatically returns to its initial point ready to start a new cycle.

To simplify setup, a switch is provided which positions the machine elements to any selected point in the cycle and a push button initiates the next action without waiting for the trip dog to function. If, during the operation, the operator wishes to determine where the machine is in its cycle, he need only turn the selector switch; the panel light will come on when he has reached the active event. The operator may also stop the machine at any part of the cycle and resume the cycle without returning to the original starting point.

Tracer control can be programmed into the cycle as simply as any other machine function. Accurate stop within 0.001 in. can be pegged in as an automatic function. A further advantage of Telematic control is that several depths of cut can be made in a single cycle even if trip dogs must be bypassed to reach the required depth. No trip dog is activated unless its function is pegged in the control board for that particular event in the cycle.

When it is required to follow one event very closely with a second event, the trip dog for the second event is set in a different T-slot and will actuate its event even though the first-event trip dog is still partially depressing its plunger.

Templates, with only holes punched to program a specific job, can be superimposed over Telematic panel. Cincinnati will provide either unpunched templates or templates punched for specific jobs. Templates punched to program specific jobs can be removed and stored to facilitate setup for reruns.

Liquid-Fluidized-Bed Reactor

UNDER the terms of a 17-month $838,163 AEC contract, the Nuclear Division of The Martin Company will continue analyses and tests of the liquid-fluidized-bed-reactor system, LFBR, and will build and operate the first critical experiment to produce a small amount of power for test purposes.

The LFBR could lead to complete elimination of the need for control rods and the complex actuating equipment associated with them. It could also cut fuel-fabrication costs and make it easier to recover valuable fissionable material from the reactor core after use.

The reactor core would be in the shape of a large, upright cylinder. The fuel would consist simply of a heap of pea-sized pellets of slightly enriched U-238 completely immersed in liquid inside the cylinder.

In order to produce a chain reaction in such a mixture, a fairly large percentage of the neutrons must ignore the U-238 and seek out the U-235 with which the fuel is enriched. It is the absorption of neutrons by the U-235 atoms that brings about the fission process.

The cylinder upright has an inlet at the bottom and an outlet at the top. When the reactor is not in operation, the pellets rest on a perforated plate with holes large enough to permit rapid water flow but small enough so that the pellets can't fall through.

In this "collapsed" position, the small amount of U-235 in the bed of pellets will not support a chain reaction. There simply isn't enough room between the pellets for the amount of liquid moderator needed to slow the neutrons down to an efficient "splitting speed."

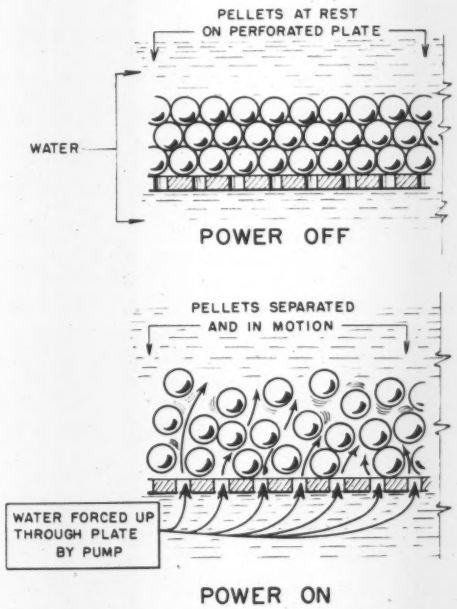
If pumps cause the liquid to surge upward and to force its way through the pile of pellets, however, the pellets will tend to rise and separate from one another to make room for the upward-flowing liquid. By controlling the flow carefully, the pellets can be separated by just enough liquid to maintain a power-producing chain reaction. Preliminary studies indicate that there is a reasonably wide range in which an efficient reaction could be maintained.

The new reactor design will contain a built-in safety mechanism, since any decrease in the flow rate would cause the pellets to fall back into a close heap at the bottom of the core and thus automatically cut off the power output.

Water will be used as the "fluidizing" liquid in the reactor core built for the critical experiments, but organic materials have also been studied and are still under consideration.

A number of fabrication problems remain to be solved, but the company hopes that the use of the pellets themselves as fuel elements will eventually simplify and reduce the cost of production, refueling, and reprocessing.

Studies indicate that fuel would be consumed at a uniform rate throughout the LFBR core, and heat-transfer characteristics should be excellent. A very high conversion of U-238 into fissionable plutonium takes place and the plutonium can be recovered by reprocessing.



Since separation by a liquid moderator is required for operation of the LFBR, power is turned on simply by forcing liquid through plate

The concept of a fluidized-bed reactor has been recognized for several years, but the AEC contract represents the first effort to produce an actual workable core. Martin's Nuclear Division previously conducted a six-month feasibility study for the Commission and also undertook company-sponsored investigations of the system as early as 1955.

Under its contract, the company will study abrasion effects on various types of fuel pellets, both with and without metal cladding, in addition to conducting the "zero power" tests.

Happy Landings

LANDING SHOCK is being experimentally reduced and impact energy dissipated with automatic partial deflation of landing-gear tires upon landing. This "high-flotation" system is a product of research at Battelle Memorial Institute, Columbus, Ohio, for the Fairchild Engine and Airplane Corporation, prime contractors to the U. S. Army Transportation Corps for the research. Conceived by Fairchild engineers, the system was developed by Battelle after a feasibility study by the Institute's Applied Mechanics Division.

Designed for aircraft which would not be limited to operations from paved runways, the tire is automatically deflated through a sleeve valve that is controlled by the vertical load, or weight, bearing down upon the landing gear. The valve automatically closes when a given minimum tire pressure is reached. In this way, the landing shock is reduced and the impact energy is dissipated. Joseph A. Hoess, the Battelle technologist largely responsible for the design of the system, worked with a tire whose pressure can be rapidly reduced from 17 to 2 psi upon landing.

Once deflated to a minimum pressure level, the tire can travel more easily over soft earth or sand. John E. Voorhees, Assoc. Mem. ASME, assistant chief of Battelle's Mechanical Research Division, explained that the weight of the aircraft is distributed over a greater surface when the tire pressure is reduced, hence the tire will not sink as deeply into the ground.

Low-pressure tires on unpaved landing fields also roll more easily over such ground obstructions as rocks and debris. Where a conventionally inflated tire tends to bounce off an obstruction, the low-pressure tire "wraps itself around" the obstruction and rolls over it with little difficulty. The tire presents equal advantages in take-off from unpaved areas.

Low-pressure tires must be several times larger in volume than conventional tires to bear comparable loads. To overcome this problem of bulkiness, a specially built tire of high-tensile nylon and natural rubber, which is automatically and fully deflated upon take-off before being retracted into the aircraft, is being employed. The tire, which is thin and pliable, is folded into a helical bellows, reducing its volume to less than one fifth of its inflated size. The tire is carried during flight in this compact condition and is only fully inflated—again automatically—just prior to landing.

The original experimental system was designed to carry a static load of 750 lb. More recently a 1500-lb static-load capacity per wheel has been used. Landing conditions have been simulated in the laboratory with "drop tests."

Small Transistorized Computer

A SMALL transistorized computer which can perform more than 100,000 calculations a minute will be available late next year from the San Diego, Calif., plant of the Data Processing Division of International Business Machines Corporation.

About the size of an average desk or drafting table, the new IBM 1620 Data Processing System operates under the direction of an internally stored program of instructions. It can perform complex engineering and scientific com-

A small transistorized computer which can perform more than 100,000 calculations a minute will be introduced late next year

putations on a continuous or production basis. Conventional decimal arithmetic is used. Addition, subtraction, and multiplication are accomplished automatically by a table-look-up method. Division is performed by available subroutine using arithmetic operations and logic. A programmer need write only one instruction to perform division.

The 1620 is particularly adaptable to problems such as highway cut-and-fill and bridge design, oil-pipeline transmission and product inventory, petroleum-blend evaluation, lens design, and power-requirements analysis for utilities.

Advanced features include 20,000 alphameric digits of magnetic-core storage with variable field length and immediate accessibility, and paper-tape and electric-typewriter input and output. The availability of two advanced programming systems and a comprehensive library of mathematical and statistical routines simplifies programming for the 1620. Specific programs for the petroleum industry, public utilities, civil engineering, and optical firms will be available.

The system will rent for $1600 a month, and sell for $74,500.

Nuclear Saline-Water Conversion

THE Department of the Interior and the Atomic Energy Commission have signed an agreement for co-operative development of a nuclear-powered saline-water-conversion plant. (For details of the Department of the Interior's long-range saline-water-conversion program, see MECHANICAL ENGINEERING, September, 1959, p. 71.)

Under the agreement, the AEC would design, construct, and operate a 40,000-tkw, experimental, low-temperature process-heat reactor capable of producing saturated steam at pressures from 5 to 175 psig. The Department of Interior would design, construct, and operate a saline-water-conversion plant which would use steam from the reactor to produce at least 1,000,000 gal per day of fresh water.

Because construction funds have been appropriated for the reactor but not for the conversion facility, the agreement is contingent upon funds being made available to the Department of Interior for its facility.

The pressurized-water-type reactor would be used to determine the economic and technical feasibility of nuclear reactors for producing process heat also applicable in such uses as the production of primary metals; and petroleum, coal, chemical, food, and paper products.

The saline-water-conversion plant would incorporate advanced concepts of the multistage flash-distillation process designed to demonstrate the economic and technical feasibility of sea-water conversion.

To enable the AEC to conduct an experimental program without interfering with the continued operation of the conversion plant, the reactor and the conversion plant would be capable of operating independently of each other. The combined facility would be located at Point Loma, San Diego, Calif. Estimated cost of the reactor is $4 million and estimated cost of the conversion plant is $2 million.

Architect-engineering services for the reactor are being performed by Sargent and Lundy of Chicago. Design services for the conversion plant are being performed by The Fluor Corporation, Whittier, Calif. Construction and preoperational testing are scheduled for completion in January, 1962.

Strain Measurements

Two unusual techniques for obtaining strain measurements are being used at Battelle Memorial Institute, Columbus, Ohio. One permits accurate measurement of strain for indefinite periods in equipment immersed in boiling water; the other is for making strain measurements at critical points in mated mechanical parts.

To protect a strain gage used in boiling water, the gage is housed in a brass blister-type pod, about the size of a quarter, that is soldered to equipment under study at a point where strain measurement is desired. Wires leading from the pod are enclosed in a stainless-steel

Protective brass blister-type pods and stainless-steel sheaths for the lead wires permit long-term strain-gage measurements in boiling water

sheath. This technique is considered "vastly superior" to the use of chemical coatings to protect strain gages from damaging effects of boiling water. In cases where chemical coatings might adequately protect a strain gage against boiling water for 24 hr, the metal blister pod will provide protection indefinitely. Development of this technique was occasioned by two recent studies conducted at Battelle—one involving water-cooled rolling mills, and the other involving engine cylinders.

To use strain gages for measurements in closely fitted parts, advantage is taken of recent developments in thin, foil gages, and also of the newer epoxy resins. For example, the gage is placed in a shallow groove cut in one of two mated parts, such as a drive shaft. Epoxy resin is used to insulate the gage and fill in the groove before the mated parts are assembled for study. "This refined technique," according to Nelson A. Crites, Battelle instrumentation specialist, is "one step closer to the pin-point accuracy sought in strain measurements of mated parts."

All-Electric Home

THERE are now over 15,000 electric-home-heating customers on the American Electric Power System; according to one another of their recent publicity releases.

"Our average residential electric heating customer is now using 20,800 kwhr per yr for all his electricity requirements," Philip Sporn, Honorary Mem. ASME, and president of American Electric Power Company states. "For this energy he is paying an average of $1^1/_2$¢ per kwhr, or about $312 a year. In some cases, the total cost for all his electric uses—not only heating and cooling but also cooking, laundry, water heating, and scores of other household tasks—has proved to be less than the cost of another heating fuel alone.

"This growing acceptance of the all-electric home," Mr. Sporn continues, "not only foreshadows the time when 25 per cent of all American homes will be all-electric homes, but their influence on the national average annual residential use will be to lift it to a figure of close to 10,000 kwhr per year. And the influence of this will extend to all industry and particularly to the entire electrical industry."

The AEP System provides electric service to over 5,000,000 people and 2300 communities in seven states—Indiana, Michigan, Ohio, Kentucky, Tennessee, West Virginia, and Virginia. The company recently became the first private electric utility to achieve energy sales of more than 25-billion kwhr in a 12-month period, an increase of 16.3 per cent over sales for the similar 1958 period.

Satellite-Reflected Phone Messages

AN EXPERIMENTAL ground station for sending and receiving telephone messages by way of man-made satellites is under construction by Bell Telephone Laboratories on Crawford Hill, at Holmdel, N. J. It may lead to a network of terminals for sending phone calls and live television to distant parts of the world. Radio signals would be "bounced" off dozens of "sky-mirror" satellites to study transmission effects and the reflection characteristics of satellites in orbit.

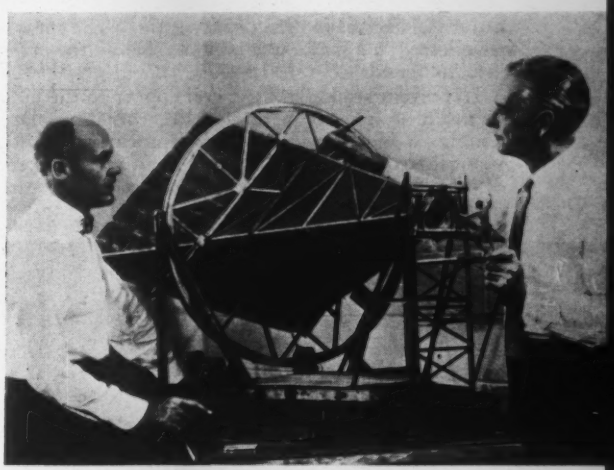
Although single telephone channels will be used in the experiment, the objective is to determine whether television's "broadband signals" (the equivalent of about 900 telephone channels) could also be transmitted. Such broadband signals cannot now be carried over present submarine cables and cannot be transmitted directly by radio between widely separated points because the signals are blocked by the earth's curvature.

The satellite experiments probably will be preceded by test transmissions of signals using the moon as the reflector. The signals will be received and transmitted between the National Aeronautics and Space Administration Jet Propulsion Laboratory tracking station at Goldstone, Calif., and Bell Laboratories, some 2300 miles apart.

A dish-shaped commercially available antenna will be used to transmit signals, and a horn-shaped antenna will be the receiver. The horn-reflector design developed some years ago by Holmdel engineers for radio-relay use permits the antenna to receive radio energy from essentially one direction, and less than one-millionth as much from other directions. The result is greater concentration on the wanted signal and less pickup of "noise" from other directions.

In conjunction with the horn, a highly sensitive receiver is required. The receiver will utilize extremely low-noise amplifiers, either a pair of "parametric amplifiers" or "masers," or a combination of one each. The central element of a parametric amplifier is a semiconductor. Maser is short for "microwave amplification by stimulated emission of radiation." The central element is a ruby crystal contained in a liquid helium "refrigerator" approaching absolute zero—about −460 F.

One of the initial and crucial problems in these experiments will be tracking speeding satellites precisely, and for this purpose Bell Laboratories will devise its own special equipment. Data predicting the "passes" of satellites will arrive in coded form and the new equipment will rapidly convert the information into a form suitable for controlling the antennas.



A horn-shaped antenna, scaled by the model of the workman near the apex, receives radio energy from essentially one direction and less than a millionth as much from the other directions

The first proposal for a system of satellite communications was offered in 1945 by A. C. Clarke. In 1955 John R. Pierce, director of communciations research at Bell Laboratories, proposed this system of passive satellite relays.

Continuous-Casting Machine

Copper in all its various forms—from phosphor deoxidized and oxygen-free to fire-refined and tough-pitch—can be handled in a new copper billet and slab-casting machine announced by Loma Machine Manufacturing Co., Inc., of New York. The basic design of the machine also lends itself to the casting of brasses, bronzes, aluminum, and magnesium alloys. The shapes produced on the unit include round piercing and extrusion billets, square wire bars, and rectangular slabs. The production capacity of the machine which requires only a single operator ranges from 3 tons per hr for double-strand casting of 3-in-diam billets to 10 tons per hr for single-strand casting of $5^1/_2 \times 33$-in. slabs.

The Loma continuous-casting machine is usually fed with liquid metal from either an arc or induction melting furnace followed by an induction holding furnace. The molten copper at a temperature of 2150 F then flows through a special refractory-lined distributor equipped with downspouts extending into the molds. The rate of flow of the metal through the downspouts extending below the metal surface is controlled by the operator with needle valves. This "underpouring" method insures a smooth, splash-free entry of clean metal into the mold cavity, thus eliminating internal porosity and inclusions in the cast material.

The billet, bar, and slab molds are of copper construction and are mounted at the top of the casting machine. The mold water jackets feature a special internal-baffle design which greatly enhances their heat-removal capacity. The cooling water initially flows through the mold jackets and then emerges from an adjustable slot at the mold bottom to impinge on the solidified metal surface in direct spray form. The spray water is collected in a water box mounted below the molds and is recirculated.

To prevent sticking of the cast copper to the mold and to insure a smooth metal surface, the entire mold assembly is oscillated by a reciprocating gear. The vertical stroke is only a fraction of an inch, and the rate of vibration of the mold can be adjusted up to several hundred cycles per min by means of a variable-speed drive

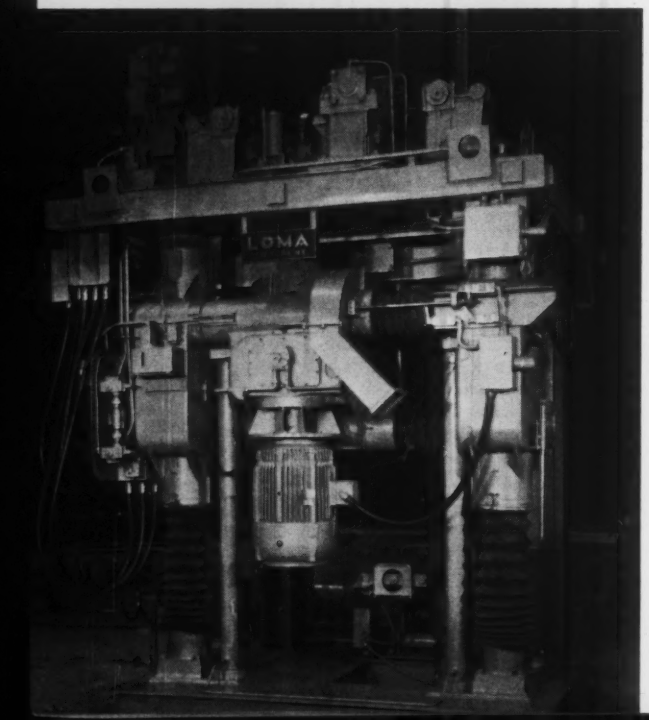
The solidified metal strands are continuously withdrawn from the molds by a double set of 9-in-diam pinch rolls made of stainless steel. Proper clamping pressure is applied to the pinch rolls by opposed hydraulic cylinders and, in addition, spring pressure is provided to hold the stock firmly in cases of power failure. The pinch rolls are driven through reduction gearing by a 5-hp d-c motor to obtain infinitely variable casting speeds up to 60 in. per min.

Immediately below the withdrawing rolls and mounted on a traveling carriage is the flying circular cutoff saw. The vertical travel of the saw is along two of the four main columns of the machine, while its horizontal travel is along two horizontal columns on which the traveling carriage is guided. During cutoff, the descending castings are engaged by hydraulically operated clamps situated on both sides of the sawblade.

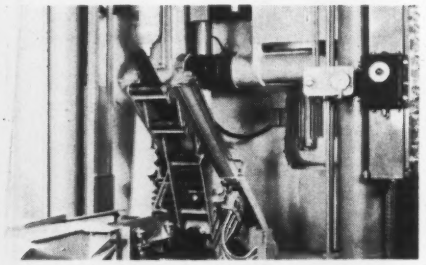
The saw employs a 36-in-diam high-speed steel segmental blade driven by a 40-hp motor at 1200 fpm. The cutting-feed rate is adjustable up to 2 ips while the return rate is 4 ips. The entire cycle of clamping, carriage descent, saw advance, saw return, and carriage return is performed automatically.

The cut billets or slabs are received in the discharge basket which is tilted automatically by a pneumatic cylinder through 90 deg. Once the basket reaches its horizontal position, the castings are ejected onto a roller conveyer by air-cylinder action. Finally, an air-operated stamping device applies an identification mark to one end of each casting. The product is then removed to stockpile or immediate use.

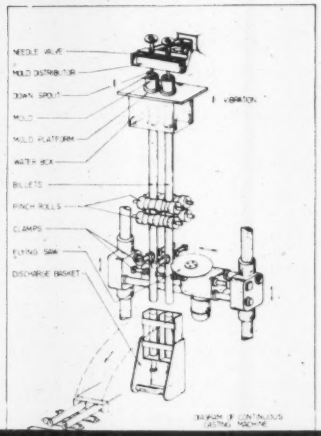
The major advantages of the machine are: (*a*) Steady casting conditions give uniform, dense ingot structure from end to end; (*b*) smooth metal pouring eliminates turbulence and entrapped oxides, dross, and gases; (*c*) rapid cooling produces a fine-grained, sound structure even in large cross sections; (*d*) predominantly longitudinal solidification prevents piping and internal stresses; (*e*) long casting length and absence of cropping losses improve yield; (*f*) simple, short molds reduce cost of and space required by casting-shop inventory.



Billets from 3 to 5 in. in diam are continuously produced by this casting machine. Pinch rolls operated by opposed hydraulic cylinders continuously draw down solidified metal strands from the vibrating mold (above area of photo). A flying circular saw clamps to the descending castings, completes a cut, and then returns up the column to travel down with the next section.



Cut billets are received in a discharge basket which automatically tilts through 90 deg and ejects the castings onto a roller conveyer by air-cylinder action



Mail sorting is tripled in speed with a new sorting machine. Letters pass in front of human operators seated at keyboards. The operators press several keys at once to route them to 279 destination bins with the aid of 161 small letter carts that are in constant motion. The supervisor at the end of the console determines rate of sort, supply of raw mail, and over-all operation of the machine while mail is removed from the back of the machine.

Letter Sorting

THE tedious "peak-and-poke" method of sorting letters into pigeonholes, used since time immemorial, is about to be replaced. The U. S. Post Office Department has been experimenting with imported models of letter-sorting machines at the Silver Spring, Md., and Washington, D. C., post offices and has placed a $1,869,000 research and development contract with the Burroughs Corporation for 10 machines of completely new design.

In addition to being the first machines made entirely in the United States, the Burroughs Letter Sorters are built on the modular principle and hence are the first readily adaptable to post offices of varying sizes. Detroit, the sixth largest post office in the country has received the first machine. This has the maximum of 12 sorting keyboards, but a medium-sized post office could start with six consoles and add keyboards to the same machine as volume increased.

Although the machine triples the output of postal clerks, the jobs of career employees will not be endangered since the U. S. already has two thirds of the entire world mail volume and this is increasing further every year.

Detroit will have 30 of the letter sorters in a $23-million post-office building to be completed next year. Another machine is being installed at Flint, Mich., and others are scheduled for Washington, D. C., and numerous other postal facilities.

Letters move automatically in front of a human operator seated at a keyboard who presses several keys as each letter passes. The machine routes the letter to any one of 279 destination slots and can handle 43,000 letters an hour.

Intermixed letters of varying sizes from $2^3/_4 \times 4$ in. to 6×12 in. in size are loaded into a hopper at each operator console. A vacuum-head arm automatically selects the letters one at a time and places them on a scanning board in front of the operator, who reads the address and indexes the destination on a keyboard with 10 keys similar to those of a piano. The letter then drops into the conveyer system.

The conveyer consists of 161 letter carts that are constantly in motion. Each cart is divided into 12 compartments with a shaft holding a series of nylon code wheels extending out from the compartment. An electromechanical signal from the keyboard arranges the code wheels so that a letter is released into the appropriate bin when the wheel passes over a complementing code pattern at the destination. The wheels then pass through an ingenious decoding unit and the process is repeated.

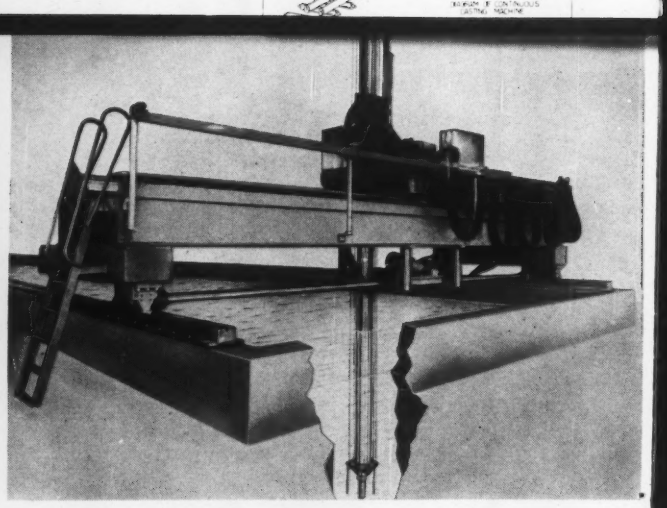
The 12 compartments correspond to the 12 operator consoles. Each compartment carries only one letter at a time and that is from the corresponding console—a letter processed through the first console drops into the first compartment of each cart, one from the second console drops into the second compartment, and so on. If the address on a letter is illegible, the operator sends it to a reject pocket simply by depressing all of the keys at once.

Speed of the conveyer system, and thus the sorting operation, is controlled by the supervisor. If operators are sorting 43,200 letters an hour, for example, the conveyer system moves at a speed of 21 in. per sec.

The machine's 279 sorting bins are arranged in tiers and are easily accessible for emptying. An alarm system at the supervisor's control station signals when a bin is near capacity. The number of letters processed by each operator is automatically counted and each letter is coded with a symbol identifying the operator control station where it entered the system.

In addition to the 10 actual machines, Burroughs is furnishing 10 training devices. Each of these training devices will have 10 practice keyboards or total facilities for training 100 clerks. The training machine simulates sorting speeds encountered on the actual sorter and records the number of correct and incorrect sorts made by the trainee.

The cutting table of a new shape-cutting machine uses pantograph arms and four motorized torches



A 30-ton instrument bridge precisely positions submerged radiation probes or detecting instruments under remote control

Shape-Cutting Machine

An 8-ft cutting machine of pantograph type designed for medium-duty shape cutting on the economical 8-ft-size steel plate, called the Linagraph, is the latest addition to the Air Reduction Company, Inc., line of shape-cutting machines. Equipped to carry a maximum of four motorized torches for use with acetylene, propane, or natural gas, it is capable of shape cutting and straight-line cutting anywhere within a rectangle bounded by a 96-in. width and an indefinite length determined by the number of rails and tracks used. The tracing area is provided with a movable 8 × 4-ft template-top.

The principal innovation in the design of the Linagraph is its centralized operator control. All controls for gas pressure, the motorized torches, the machine carriage, and the tracing device are located directly above the mobile tracing table within easy reach of the operator. This centralized system not only simplifies the over-all operation, but cuts down the floor space necessary for the installation of the machine since both the tracing area and the machine carriage occupy the same space. The machine is powered by a 110-volt a-c electric motor.

The Linagraph can be set up for either left-hand or right-hand operation and can be equipped with manual, magnetic, or Aircotron—Air Reduction's electronic type—tracing units.

The package unit for the Linagraph includes the machine carriage, torches, control mechanisms, tracing table, all necessary structural parts, and 20 ft of track.

Remotely Controlled Instrument Bridge

A remotely controlled 60,000-lb instrument bridge will span two deep-water pools at the AEC's National Reactor Testing Station, NRTS, in Idaho. The bridge will move on 90-ft-long precision rails with integral gear tracks to position radiation-measuring probes or detection instruments at precisely determined positions.

The huge device was built by the Nuclear Equipment Department, Mechanical Division of General Mills, for use by the General Electric Company primarily in the testing and evaluation at NRTS of shielding materials for use in nuclear-powered aircraft.

A mast which projects downward from the bridge, and is also remotely controlled, will determine the vertical positioning in the 30-ft-deep pools.

Position-indicating racks, components of the bridge-control system, are described as more precisely machined than the gears of a fine watch. An analog-to-digital encoder can be preset to move the mast automatically to any position in either pool.

The X, Y, Z (three common dimensions of a cube) and alpha (rotational) positions of the probe, plus measurements taken by the instruments, are all fed to a remotely located control unit and correlated there. The system can accept measurements at extremely high speed.

Automatic Train Operation

Completely automatic train operation without the need for an operating crew is possible and practical today from an engineering viewpoint, according to W. A. Robison, design engineer from Union Switch & Signal, a division of Westinghouse Air Brake Company.

Mr. Robison stated in a talk at an Association of American Railroads meeting in Washington, D. C., that most of the equipment already being used in manual, semiautomatic, and automatic operations on many railroads, some in service for several decades, can also be applied to achieve fully automatic operation. In addition, the existing geographical patterns and physical layouts of railroad systems make them the only form of transportation which can so conveniently make use of automated operation.

The automatic traffic-control system would, basically, consist of "decision-making devices" or electronic brains located along the railroad rights-of-way, to make decisions based on the traffic situation concerning routing, starting, acceleration, deceleration, and stopping of trains; servo units mounted on locomotives to control train movements as commanded by the decision-making devices, and a monitoring panel from which a dispatcher would supervise train movements.

The decision-making devices would be designed to automatically request manual assistance from the dispatcher for a problem beyond its capacity to handle.

Mr. Robison stated that today's train dispatcher spends a large percentage of his time handling routine telephone calls and maintaining records of train movements. He pointed out that eliminating most of this work would not be a major problem. Push buttons at wayside locations would be used to request routine information from the automatic control system, and an

automatic method would be used to maintain continuous records of train movements.

By freeing the dispatcher from these routine duties, and installing automatic equipment along the wayside and on locomotives, the dispatcher would only have to monitor train operation and would then be able to supervise train movements over much longer distances.

Some of the more difficult problems, which are being solved leading to the crewless train, include stopping a train smoothly and accurately at a predetermined location, handling switching moves of local trains, and control of helper locomotives.

Limited automation has already been successfully applied to railroad operations. There are robot switching locomotives in freight-classification yards which are remotely controlled. Consideration is being given to the remote control of helper engines as well as remote control of in-plant switching movements.

Tests are now under way in New York for the small-scale operation of a completely automatic train in which starting will be initiated by an automatic programmer, and the train will proceed to and stop at its destination. Automatic equipment will control its acceleration, its normal running speed, and a planned decrease in speed for stopping at the desired station.

The system will make use of earlier devices perfected by Union Switch & Signal such as the continuous inductive cab signal and automatic train-control system used by the Pennsylvania Railroad since 1923, the coded track circuit for signal indication inside the locomotive in use by the Pennsylvania since 1933, and inductive cab signaling used by the Louisville and Nashville Railroad since 1954. A very important component will be Union's Identra train-identification system first installed by the Chicago Transit Authority in 1954. This system makes it possible for a train to align its own route, identify itself at station platforms, and perform many other automatic operations.

Materials Briefs

▶ Laminated Safety Glass Reduces Explosion Hazards

LAMINATED safety glass, of the type used in automobile windshields, has been proposed for windows of industrial control rooms and other structures exposed to hazards of explosions by D. Kent Hatch, Monsanto Chemical Company engineer.

The resilient plastic film between the two sheets of glass allows it to break but not shatter because the pieces are held together by the plastic interlayer.

Unlike other types of safety glazing, it becomes "limp" under serious explosive conditions and folds safely from the window. This seems to occur at a pressure just below that at which structural failure begins to take place, thus reducing the likelihood of building collapse and subsequent human injury.

Monsanto is planning a comprehensive and detailed program to evaluate the explosion resistance of various glazing systems in co-operation with the Liberty Mutual Insurance Company and government agencies.

▶ Extinguishing Fuel and Electrical Fires

A new chemical compound, considered to be twice as effective as any other extinguishing agent against liquid fuel and electrical fires, has been adopted for emergency use at Army installations.

Known as "monobromotrifluoromethane," the compound can also be used to prevent fires by mixing it with helium or nitrogen, thereby creating a combustion-free atmosphere, allowing dangerous jobs to be conducted in safety.

Standardized along with the agent was a special cylinder that weighs less than 3 lb and holds 1 qt of the compound. The container features a specially designed nozzle that can discharge the fluid in from 10 to 12 sec.

Developed by the Army Engineer Research and Development Laboratories, Fort Belvoir, Va., the new agent can be used in temperatures as low as −65 F and will be particularly helpful in the Arctic, where fire is a crucial problem. Nontoxic and noncorrosive, it can also be used safely in homes.

Tests are now under way on 15 and 50-lb containers which will eventually replace 14 sizes now used with carbon dioxide and carbon tetrachloride, and a recharging unit has already been developed.

▶ Kralastic MM, High-Rigidity Creep-Resistant Plastic

Kralastic MM, a resin-rubber blend, is a tough new plastic specifically designed for molding products where high rigidity and resistance to cold flow under loads are required. Developed by Naugatuck Chemical Division, United States Rubber Company, it is described as a medium-impact plastic with greater rigidity and less tendency to creep under load than any thermoplastic material now being marketed.

Rigidity is about twice that of nylon and resistance to creep four times greater. It has low moisture pickup, good impact strength, and high abrasion and corrosion resistance. It maintains usable strength up to 200 F.

▶ Commercial Production of Ultrapure Metals

The output of high-purity metals (99.999 per cent or better) is soaring according to *News and Progress in Metals*, issued by American Smelting and Refining Company. For almost 20 years high-purity copper, for example, has been solely a research material. It was used as a standard—a research yardstick—and that is about all. Now it is being appraised for its functional properties. Unique electrical conductivity near absolute zero (actual working temperatures are 2 or 3 K) offers potential applications.

Ultrapure arsenic and such compounds as gallium arsenide and many arsenic derivatives are being evaluated. Arsenic-derived semiconductors are being considered.

Cadmium of 99.99-plus per cent purity is being produced in tonnage lots, and a significant percentage of available tellurium is being produced in the 99.99-plus per cent purity classification.

▶ Cast Silicon Lenses, Domes, and Flats

Optical-quality silicon—largely used for infrared sensors in military weapons systems—can now be cast with a system perfected by Hughes Aircraft Company metallurgists. The new process permits volume production of silicon lenses, domes, and flats. Domes with an OD of more than 8 in. have been successfully cast. Final finishing, kept to a minimum by holding castings to close tolerances, is performed on standard optical machinery.

PHOTO BRIEFS

1 **For Hydraulic Turbines.** It will take 475 precision-fitted forged-steel nuts and bolts like this for Allis-Chalmers' York, Pa., works to assemble the seven 140,000-hp units for a hydroelectric project at Wenatchee, Wash. These are for turbine couplings.

2 **Longest Evaporator.** Evidence of man's continuing struggle to convert sea water to fresh water: Cleaver-Brooks Special Products of Waukesha, Wis., designed and engineered what is believed to be the world's longest evaporator for Southern California Edison's Mandalay Steam Station near Oxnard, Calif. It will be America's first such plant operated in conjunction with a steam-electric power plant.

3 **Separate Treads.** Have you applied your winter tread bands? You may, some day, with these tires by Pirelli of Milan, Italy. No vulcanizing: Simply put on the tread pattern most suitable to the weather and the terrain. Bands may be applied without special tools, tire is then inflated, and it is ready for the road. Ice spikes can be located in central ridges between tread bands (three bands on a tire). Normal, winter, and ice—three tires from one casing.

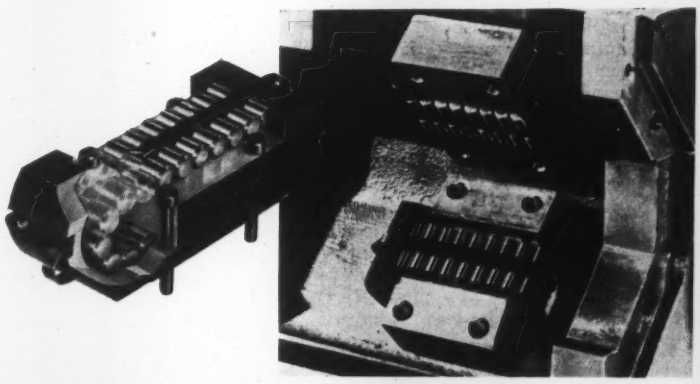
4 **Recirculating Roller Bearing.** This Tychoway bearing, manufactured by Scully-Jones and Company, Chicago, Ill., makes possible great accuracy in the V-ways of Kearny & Trecker's Milwaukee-Matic, numerically controlled, multipurpose machine tool. The cutaway shows the return channel, flat race, and recirculating rollers. The mating way of the machine serves as the other race.

5 **Pliolite 5352.** That's Goodyear's name for the synthetic latex from which this molded cushion is made. The company's Foam Rubber Division is converting entirely to this new premium foam rubber for Airfoam, which can be sold at 20 to 30 per cent under natural latex prices. Complete changeover is expected early in 1960.

6 **Wagon Train on Rubber.** This side-dumping "wagon train" made by Differential Company, Findlay, Ohio, increases the payload that each driver can haul, and provides quick, convenient unloading. Light weight, multi-axle construction, economizes on fuel, tires, maintenance, license fees, and private-roadway costs. The patented trains are built in two sizes: One for highway use with 15-ton-capacity bodies; a larger, off-highway train with bodies carrying 25 tons each.

7 **Miniature Transmission.** Press the right button, and this tiny 15-speed transmission gives you any of 15 precisely controlled speeds from 3.5 to 7812 rpm. Made by Dynamic Gear Company, Amityville, N. Y., the transmission, about the size of your hand, is electronically controlled by magnetic clutches and is used for recording instruments such as oscillographs, requiring constant and precise paper feeds—also as a laboratory device for testing servo packages.

3



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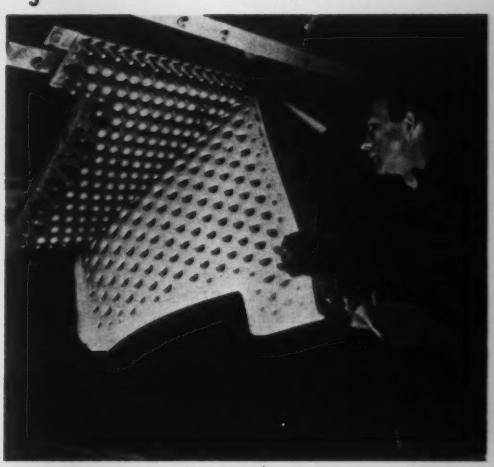

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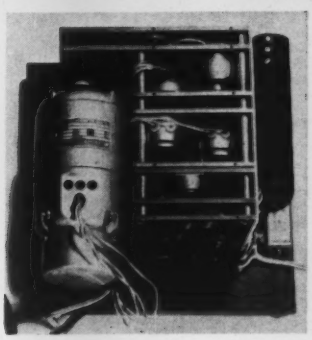


7

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European
Correspondent

EUROPEAN SURVEY

Goliath Crane

WHAT is claimed to be the world's largest crane is now in use at the Hinkley Point Atomic Power Station, England, for placing in position the shells of the steam-raising units and sections of the prefabricated pressure vessels in the reactor house. Some of these lifts amount to 390 tons—only 10 tons less than the rated capacity of the crane. It is of the Goliath type, stands 250 ft high, and travels on its own rail track. The width of track is sufficient to enable the crane to span the reactor buildings.

The design and construction of the crane were undertaken by Babcock & Wilcox Ltd. at their Renfrew works, in Scotland. The illustration shows the erection process. The side frames were erected first on their respective tracks, using temporary fixed cranes and derrick masts, and were then held in position by guy ropes. At the top of each frame was a powerful hoist. Meanwhile, the girder span was erected on the ground between the frames and, when completed, was raised by the hoists and secured to the frames. The crane is designed to be taken down by a reverse process, so that it can be used at other nuclear power stations as required. There are now four others under construction in the British Isles, work having been started recently on the Trawsfynydd station in North Wales; this 500-mw plant is being built for the Central Electricity Generating Board.

Goliath crane, claimed to be world's largest, has 400 long tons lifting capacity and is being erected at Hinkley Point Atomic Power Station

Automatic Vertical Lathe

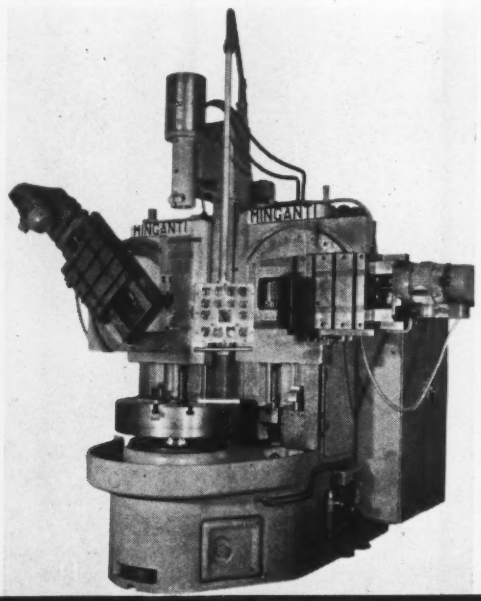
DESCRIPTIONS of selected exhibits from the European Machine Tool Exhibition must be spread over several "Surveys" if other subjects are not to be crowded out, but a start may be made with an automatic vertical lathe shown by the Italian firm of Giuseppe Minganti & Company, Bologna, Italy.

This machine is designed to carry out internal and external turning operations simultaneously, the toolholders being mounted on two slides, one on each side of the table, which are rotatable in the vertical plane. The machine shown, Type TVM.01, can take a workpiece of a maximum diam of 800 mm and will cut over a height of 600 mm. The table has a diam of 600 mm and the clearance over it is 1000 mm. The slides have a vertical movement of 600 mm and a horizontal movement of 320 mm and the mountings are rotatable through 135 deg.

The vertical mandrel has 12 speeds, between 20 and 500 rpm. The toolholders have a travel of 320 mm on the slides, and can be supplied for feed rates of either 1220 or 1900 max mm per min, and slow feeds, respectively, of 12 or 18 mm minimum, according to the type of motor fitted (either 6-pole or 4-pole). The main driving motor is of $31\frac{1}{2}$ hp.

The various motions governing the paths of the tools can be carried on simultaneously, under automatic control, within preset limits.

Automatic vertical lathe performs internal and external turning operations simultaneously. Manufacturer is Giuseppe Minganti & Company, Bologna, Italy.



Machine Tool Show

THE SIXTH European Machine Tool Exhibition, which was held in Paris, September 12–21, compared well with its predecessors, even though the new and unique exhibition building in which it was held (now known officially as the Centre des Expositions) was hardly big enough for all the tools and gear that the 1001 exhibitors, from nine countries, contrived to cram into it. There were exactly 1001 exhibitors and the French were the most numerous, with 342 firms showing; though the Germans' 332 occupied the most space—13,786 sq m out of the 37,120 sq m that the building provided.

The number of large and heavy machines was impressive and must have presented some problems. It had been stated that 40 tons was the limit for one machine because the structure could not safely carry more, but some of the exhibitors had not hesitated to provide their own additional stiffening to distribute the load over a larger area. This raises the question whether, in future, there will not be an increasing tendency to design tools that can be taken to the job, where the machining of large masses of metal is involved, instead of taking the job to the tool, and there were some clear indications that a number of designers are thinking along these lines.

Improvements that have been made in recent years in the design of mobile floor cranes of considerable capacity seem likely to accelerate progress in that direction.

In an assembly of tools so large and diverse it is more than a little difficult to identify particular trends, but the general impressions received from this Exhibition were that, in most sections of the broad field, the limits of economically reproducible accuracy have been about reached; that those of cutting speed, if not actually reached in most cases, are being closely approached; and that further progress is coming to depend more and more on refinements of detail, the attractions of which to the user must necessarily be largely matters of personal opinion, based on individual circumstances. The leaning toward welded-steel frames and beds has not become more pronounced since the previous European Exhibition, but as it was caused in the first place mainly by difficulties in obtaining castings, this may mean only that the castings position is now easier.

Automatic-handling devices seemed to be rather more numerous and effective, but there was nothing to suggest that (in Europe, anyway) the "push-button factory" is just round the corner. Compressed-air and oil-pressure actuation of automatic tools appear to enjoy about equal favor, but it seemed that a lot more money was being spent on electronic-control gear than hitherto.

These, it must be stressed, are merely general impressions acquired over a considerable mileage of pedestrian exercise among some 3500 machines of all sorts. It may be that a precise statistical tabulation would reverse some of them. What it would not reverse is the conviction that five floors in an exhibition hall are at least three too many, especially with the temperature in the 80's.

Automatic Ring-Rolling Plant

THE WAGNER Werkzeugmaschinenfabrik m.b.H., of Dortmund, Germany (who are represented in the United States and Canada by Girard Associates, Chambersburg, Pa.) exhibited a fully automatic plant for producing rolled steel rings for bearing races, gears, and the like, up to a weight of about 2 lb each and at a maximum rate of some 450 per hr.

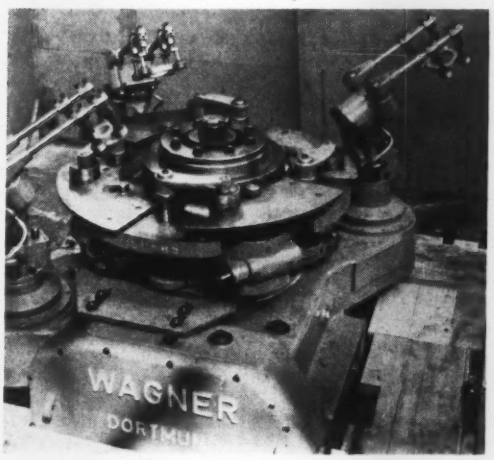
The plant comprised an induction heating unit fed by a vibrating conveyer, an automatic ring-blank forging press, and an automatic rolling mill with built-in transfer mechanism; the whole may be operated by one man.

The periodical demonstrations of this plant were among the chief attractions in the Exhibition. The hot billet from the furnace is fed mechanically to the press, which produces pierced and formed blanks of uniform size and volume, even from broken billets.

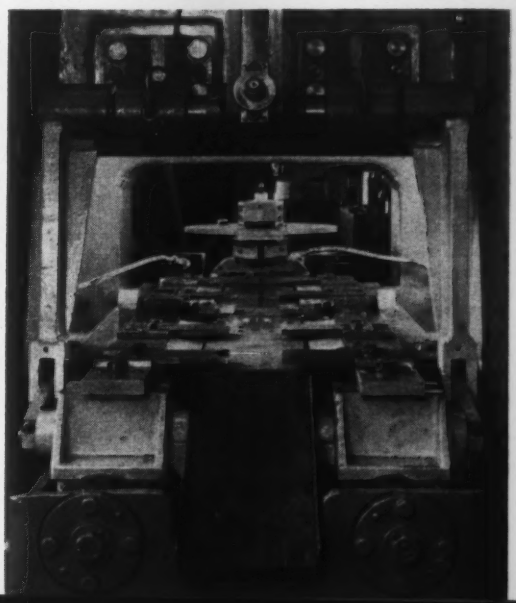
Mechanical handling devices place the blanks in the mill which operates continuously, position them on the mandrel rolls, and remove the finished rolled rings. The press has three sets of dies, for upsetting, preforming, and punching. The preforming punch is hydraulically cushioned so that its downward movement is arrested immediately the die cavity is filled, thus insuring uniformity of volume and avoiding the formation of flashes and burrs. Similar plant is being applied to roll rings up to 22-in. diam and 30-lb finished weight.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Automatic rolling mill with rings held in transfer grippers is part of automatic plant for producing rolled steel rings for bearing races, gears, and such



Transfer mechanism in ring-rolling plant for positioning blanks under press is part of automatic plant capable of being operated by one man



ASME TECHNICAL DIGEST

Petroleum Mechanical Engineering

Controlling Electric Centrifugal-Pump Stations With Variable-Speed Driver..59—Pet-48... By E. C. Michels, Continental Pipe Line Company, Ponca City, Okla. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

The adaptation of equipment, proved in other industries, to the transportation of crude oil and refined products by pipelines has been a successful means for combating rising costs in the oil industry. The variable-speed drive, long established in the power industry for controlling the output of boiler-feedwater pumps, can effectively control and reduce the operating costs of an electric centrifugal-pump station.

The head-capacity characteristics of a constant-speed electric-driven centrifugal pump can be designed to meet a limited number of operating conditions on any given petroleum pipeline handling multiple products. The various and continually changing operating conditions depend upon the throughput needs and the physical characteristics of each product. It is therefore necessary to provide a method of control so that, within a preset range of suction and discharge pressures and power consumption limits, a maximum number of operating conditions will be met.

The throttle valve is an accepted method to control the pump output. The variable-speed drive, which can also be used for controlling the pump unit, will provide a more flexible operation and reduce the power costs.

The eddy-current principle is utilized in the variable-speed drives installed on the Products Division of Cherokee Pipe Line Company's system to Wood River, Ill. Single electric-driven pump units were installed on each of the two 10-inch lines at the five booster stations located between Glenn Pool, Okla., and Wood River, Ill. These pump stations, which are remotely controlled from Wood River, have been operating since September, 1958.

It can be shown how an eddy-current drive, which lends itself to the operation, will pay out the additional investment cost compared with throttling through power savings; furthermore, by using electric demand controllers, additional throughput is obtained for any given power setting.

Reciprocating Wire Line Packer Setting Tool..59—Pet-44... By Frank Sharp and A. E. Cummins, Halliburton Oil Well Cementing Company, Duncan, Okla. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

Reciprocating wire line packer setting tools are mechanically operated for setting squeeze packers, production packers, and bridge plugs. The tool sets packers efficiently and economically, resulting in a saving for the operator.

The reciprocating wire line setting tool contains a hydraulic jack, consisting of two pistons and cylinders, one small and one large. These components are operated by the wire line that is used to run the setting tool, plug, or packer into the well. A back-pressure valve for pressure build-up is located above the setting sleeve so that hydraulic pressure applied to the setting sleeve by the pump cannot be released until the packer is set. A set of drag springs is attached to the outside of the tool to help prevent the plug or packer from moving down the hole during the pumping operation before the top packer slips are set.

Use of the reciprocating wire line setting tool offers many desirable features. Among them are the following:

1 The tool can be used in wells with or without fluid. The necessary hydraulic fluid to operate the tool is carried in the tool.

2 It eliminates special setup for electrical wire line.

3 Sand line or swab line on rig can be used to operate the setting tool.

4 Rig time is saved where tubing normally would be used in the setting operation.

5 Accuracy in placement is accomplished by "tagging" bottom, "flagging" the line, or the use of a depthometer on the running-in line. Collars can be located if run on electrical line.

Work is now being done on a combination weight indicator and measuring device to be used on a sand or drilling line. This work is being done so that more accurate measurement may be obtained with a sand line.

Mechanical Aspects of Tubingless Completions..59—Pet-42... By M. E. True and C. B. Corley, Jr., Humble Oil and Refining Company, Houston, Texas. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

Although current techniques for utilizing tubingless completions permit efficient well completion and operation as well as provide important economic savings, it is important that development work continue to obtain equipment and techniques specifically designed for small-diameter wells.

Tremendous incentive exists to develop small-hole drilling equipment and techniques with costs consistent with drilled-hole size.

Significant cost reductions in completion and operation of tubingless wells would result with development of tubular materials having costs commensurate with the steel involved and which provide increased resistance to wear, corrosion, and paraffin deposition.

A versatile system of low-cost wellhead equipment is needed for multiple tubingless completions.

Improvements of artificial-lift techniques, especially for multiple tubingless completions, should receive additional development effort.

Appreciable cost reductions and facility of operation would be effected through diligent development of the many less significant, but important, specialty tools designed for tubingless completions

A Study of Wells Producing Through Small Conduits..59—Pet-39... By C. V. Kirkpatrick, University of Houston, Houston, Texas. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

An analysis of fluid flow through vertical conduits with particular emphasis on small conduits is presented.

Small conduits are defined as $1^1/_4$-in-diam nominal tubing and smaller for tubing flow, and less than twice the $1^1/_4$-in-diam nominal tubing internal flow area for annulus flow.

Simplified techniques for calculating pressure traverses in nominal size tubing are extended to the small-diameter tubing and annuli with good checks from field performance given. A concept is presented whereby flow resistance in an annulus may be predicted by calculation in the same manner that tubing flow resistance is calculated. The proposed relation is a tubing flow conduit equivalent whose area is approximately 50 to 60 per cent of the actual annulus area. This relation is proposed for both regular and irregular annulus conduits. This suggested application is supported by field data within acceptable limits of accuracy.

Injected-gas gradient curves for small conduits based on the Buthod and Whitely formula are given.

It is concluded that intermittent gas-lift operations in small conduits should be limited to a depth of approximately 3000 ft and for continuous flow a depth of 5000 ft may limit most conventional applications. A series of one-inch tubing and 1-in. × 1-in. annulus, multiphase-flow, pressure-traverse curves are given and the comparative producing rate and pressure effect of the smaller versus the larger sizes of conduits are shown graphically. Pressure gradient charts for 1 in., $1^1/_4$ in., and $1^1/_2$ in. tubing are presented. Several field applications are cited in support of the conclusions of the paper.

Use of Rigid Polystyrene Foam Insulation for Low-Temperature Distillation Columns..59—Pet-47... By E. E. Kimmel, Koppers Company, Inc., Monaca, Pa. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

The ethylene purification section of the Koppers Company, Inc., Port Arthur, Texas, plant requires an insulation of high efficiency. The low-temperature purification process includes the use of internal heat pumps to provide a portion of the refrigeration requirements. Excessive heat losses in this system would result in process failure.

An insulation produced from Dylite expandable polystyrene was used to insulate the distillation columns and auxiliary equipment. The insulation was applied during December, 1956, and early 1957.

This selection was based on the thermal conductivity, water absorption, water-vapor transmission, mechanical properties, inertness, and ease of application of expanded polystyrene rigid foam insulation. At the time of installation, performance data had not been established for its use in a low-temperature distillation process application. The material, however, had been used extensively for commercial and domestic refrigeration applications.

The purpose of this paper is to describe the insulation material, the distillation process, the method of application, and the performance of the insulation.

The Use of Internal-Combustion Engines on Pipelines..59—Pet-33... By J. M. Monroe, Nordberg Manufacturing Company, Milwaukee, Wis. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

A review of the evolution of internal-combustion engines for crude oil and products pipelines is followed by reasons for and against their use and design considerations in the application of engines in pumping service. The author concludes with the following comments on possible future developments.

Barring large reductions in electric power rates, rapidly rising fuel costs, or greatly increased efficiencies for gas turbines, engines will continue to be used on pipelines for many years.

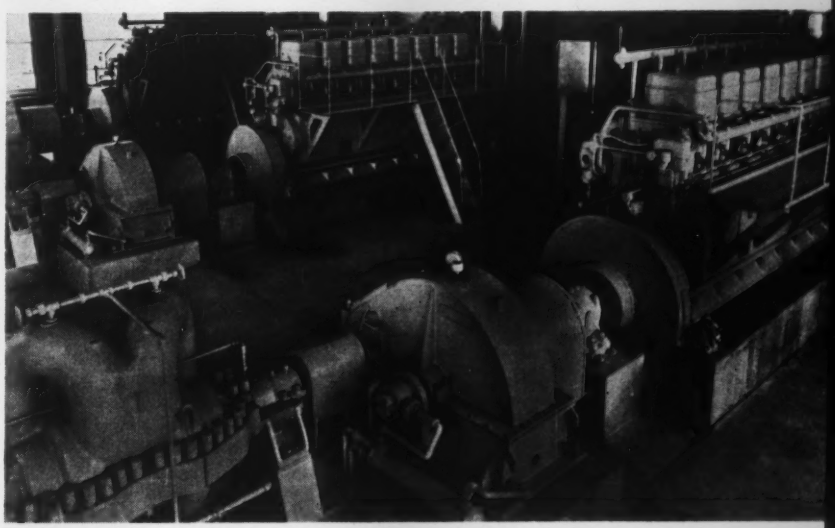
The horsepower ratings of particular units will rise, and unless there are changes in the tax structure or financial picture, more engines will be lease-rented in the future.

Efficiencies will probably improve slowly except that a considerable advance could be made by using high-temperature cooling, around 250 F, with exhaust waste-heat boilers.

If the station is large enough, the steam resulting from both the water jackets and the exhaust could be used in a steam turbine driving a centrifugal pump, or at least for radiator fan drives and building heat.

Small "packaged" units including all necessary equipment on a single skid will become more popular for low-horsepower requirements and stand-by power.

Engines will be "weatherproofed" for operation without a building or will be simply enclosed in aluminum sheeting or equivalent cover.



Typical pipeline engine installed today is a compact supercharged dual-fuel engine equipped for automatic operation. Shown here is a pipeline station using three eight-cylinder intercooled dual-fuel engines. (59—Pet-33)

Digest Report on Welded Repairs to API 5LX52 Pipe..59—Pet-34... By T. A. Ferguson, Transcontinental Gas Pipe Line Corporation, Houston, Texas. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

A series of progress tests performed to evaluate the problem of making welded repairs to high test line pipe is presented.

Tests were run on 30-in-OD 5LX52 pipe that had been removed after 9 years

of service. The pipe contained abnormal corrosion pits.

Welded repairs were made to two joints and a third joint was tested hydrostatically without any repairs.

The test indicated two interesting points: The theoretical yield point of the pipe was not reduced by the welded repairs to these sizes of defects, and the yield point was not reduced by the defect itself without any repairs.

Based on these tests along with past research, the author states that welded repairs can be made satisfactorily to a much greater degree than is presently allowed if the proper repair procedure is used.

Equipment Requirements for Air and Gas Drilling..59—Pet-41...By F. W. Smith, Technical Drilling Service, Midland, Texas. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

In rotary drilling with air or gas, it has been possible to increase bit life by tenfold and more than triple the rate of penetration over corresponding performance when drilling with mud. These factors have amounted to as much as 25 per cent savings on the total cost of drilling a well. These advantages are obtained, however, by definite equipment requirements and adjustments.

It is the purpose of this paper to present the basic equipment requirements and to show their general arrangement for drilling with air or gas.

The discussion first treats the horsepower requirements for air and gas drilling. Manifolds, compressors, wellhead equipment, and the drill string are considered as are certain equipment problems, and future equipment.

A Progress Report on the Pipeline Spheroid..59—Pet-43...By M. L. Barrett, Jr., Shell Oil Company, Indianapolis, Ind. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

Elastomer spheroids introduced at properly spaced intervals in an interfacial fluid mixture at the source of a products pipeline, and the subsequent maintenance of their relative positions in the mixture to its destination, have previously been reported as effective means of minimizing and controlling the longitudinal diffusion of such interfacial volumes in transit.

During and subsequent to this development, other applications and uses for the pipeline spheroid have been found and still others are contemplated by several pipeline companies.

A review of experiences with elastomer spheroids and a brief description of several companies' plans for their use in operations are given.

Progress in the manufacture of spheroids is outlined. The use of spheroids in hydrostatic testing of both old and new pipelines; their application in line cleaning, liquid evacuation from lines, in liquid purging from in-service two-phase lines; and liquid separation by spheres are described. Progress in the use of spheroids in positive-displacement-meter proving is noted.

Hydraulic Fracture Design..59—Pet-45... By D. D. Hunt and H. R. Crawford, The Western Company, Dallas, Texas. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

To a large extent, the success of a given hydraulic fracturing operation is determined by the area of the fracture created.

This paper presents a method for rapid determination of fracture area and volume created as a function of: Formation permeability, formation porosity, pressure differential required to fracture, formation fluid viscosity and compressibility, fracturing fluid, fracturing rate, and volume of treatment.

For a given formation, generally, it is possible to control the last three factors and select them to achieve the desired fracture area (production increase) at a minimum cost.

Nomograms are presented for calculating fracture fluid viscosity, reservoir fluid viscosity, and fluid loss additives. Also included is a nomogram for determination of fracturing efficiency and fracture area.

Application of Electronic Computers to Pipeline Operations Planning..59—Pet-46...By L. W. Ewing, Jr., Standard Oil Company (Indiana), Chicago, Ill. 1959 ASME Petroleum Mechanical Engineering Conference paper (multilithographed; available to July 1, 1960).

The increasing complexity of pipeline operations has caused a number of operators to explore the possibility of using high-speed computers. It is their goal to establish the most economic scheduling sequences of product batches in the pipeline. This is a new venture for pipeline operators and mathematicians, and its outcome may influence the ability of operators of products pipelines to conceive a completely automated operation.

This discussion briefly reviews the products pipeline facility of the Standard Oil Company and how its manual operations planning is done. The incentive and method of approach to using a large high-speed electronic computer for this work are treated in some detail.

Standard's initial goal has been reached. It is possible to produce a variety of alternate, rated pipeline schedules by computer.

Lubrication

A General Theory for Elastically Constrained Ball and Radial Roller Bearings Under Arbitrary Load and Speed Conditions..59—Lub-10...By A. B. Jones, The Fafnir Bearing Company, New Britain, Conn. 1959 ASME-ASLE Lubrication Conference paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

A completely general solution is obtained whereby the elastic compliances of a system of any number of ball and radial roller bearings under any system of loads can be determined.

Elastic yielding of the shaft and supporting structure are considered as well as centrifugal and gyroscopic loading of the rolling elements under high-speed operation.

The solution defines the loading and attitude of each rolling element in each bearing of the system as well as the displacement of each inner ring with respect to its outer ring.

For ball bearings the precise location of the load paths in each raceway are found. Life estimates can be more accurately made since the fatigue effects can be evaluated over known paths in the raceways.

The solution, which is accomplished numerically by iterative techniques, has been programmed for an IBM-704 digital computer.

A General Method for Correlating Labyrinth-Seal Leak-Rate Data..59—Lub-7... By F. E. Heffner, Assoc. Mem. ASME, General Motors Corporation, Warren, Mich. 1959 ASLE-ASME Lubrication Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

Proper selection of an optimum labyrinth seal for a given application depends upon an accurate estimate of the seal leak rate. Suitable accuracy, particularly for straight labyrinth seals, can only be obtained from actual seal tests. Testing a complete series of seals is time-consuming and expensive. A method for correlating test data is presented which allows calculation of the leak rates for an entire family of labyrinth seals on the basis of tests of only two characteristic seals. Leak rates predicted by the method are within 3 per cent of the basic test data.

The Oxidation of Lubricating Oils at High Temperatures..59—Lub-8...By A. L. Williams and E. A. Obberight, Socony Mobil Oil Company, Paulsboro, N. J. 1959 ASLE-ASME Lubrication Conference paper (multilithographed; available to Aug. 1, 1960).

Oil temperatures at the bearings of jet engines and the piston-ring zone of internal-combustion engines are now higher than in the past. The increase in tem-

peratures at which lubricants must function has stimulated much high-temperature oxidation work on lubricating oils and antioxidants.

Ideally, new lubricants should be tested in the engine in which they are to be used. However, cost of engine testing is high. The result has been the development of a variety of bench tests for screening lubricants.

The primary objective of this work was to study the early stages of liquid-phase oxidation of lubricating oils at high temperatures under highly oxidative conditions.

For the rate of oxidation to be independent of transport of oxygen into the oil, it is necessary to have a large oil surface-to-volume ratio.

These necessary requirements were met by passing preheated oil over an internally heated aluminum disk, 12 cm diam. Rotation of the hot disk at 2500 rpm exposes the oil to a high temperature in a thin film for a short contact time.

The rate of oxidation is measured by observation of the volume of oxygen taken up by the oil in a closed system.

This procedure is not considered to be a bench test for evaluating lube-oil performance in engines.

The Importance of Spinning Friction in Thrust-Carrying Ball Bearings..59—Lub-9...By G. S. Reichenbach, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASLE-ASME Lubrication Conference paper (multilithographed; available to Aug. 1, 1960).

The coefficient of friction of a ball bearing is very small, of the order 0.001 to 0.003. Yet even this small value is of great concern to designers in many applications. The main thrust bearing of a jet engine which is subject to extreme loads and speeds may absorb as much as 25 hp. The lost power is not so important as the problem of removing this large quantity of energy from the cooling oil. At the other extreme is the problem confronting the designer of gyroscope bearings used in inertial guidance systems. He has limited power available in his driving motor to overcome the friction and is troubled by navigational errors which are an outgrowth of the bearing friction. While gross values of friction coefficient for many types of bearings are known, the basic details of the motion which lead to the over-all friction force and the relative importance of the various factors are still not completely resolved.

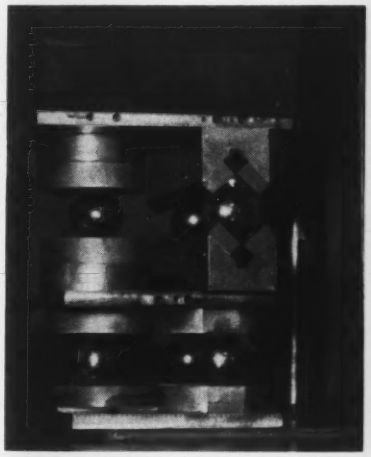
This paper restricts itself to consideration of ball bearings of the thrust type. Many of the conclusions drawn are applicable to other rolling-contact situations but they are not discussed here.

If we examine a ball in a high-speed bearing, it is found to be under the influence of several forces.

Experimental work was done rolling balls on flat plates and in V-grooves at loads and contact angles corresponding to usual thrust-bearing practice.

It is shown that the spinning action of the ball with respect to the race should account for the major part of the over-all friction of a thrust-carrying ball bearing.

Variables studied included contact angle, conformity, load, lubricant, and temperature. The results have been correlated and shown to follow theoretical predictions.



Apparatus used for experimental analysis of rolling balls on flat plates and in V-grooves measures resulting friction forces (59—Lub-9)

The Effect of Ball Bearing Steel Structure on Rolling Friction and Contact Plastic Deformation..59—Lub-2...By R. C. Drutowski and E. B. Mikus, General Motors Corporation, Warren, Mich. 1959 ASME-ASLE Lubrication Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

The rolling friction, contact plastic deformation, and elastic limit were determined for SAE 52100 steel structures with retained austenite contents from zero to 18.4 per cent.

The force necessary to roll a ball on a plate decreased as the retained austenite was decreased.

The contact stress necessary for the initiation of plastic deformation and the elastic limit of the material increased as the retained austenite content decreased from 18.4 to 3.9 per cent.

No further change occurred when the retained austenite was reduced to zero.

The extent of plastic deformation at very high contact stresses was reduced by the presence of retained austenite contents up to at least 7.4 per cent.

These observations were applied to the problem of selecting the best steel structure for an instrument ball bearing.

Bearing Oil-Ring Performance..59—Lub-5...By D. C. Lemmon, Lynn., Mass., and E. R. Booser, Schenectady, N. Y., General Electric Company. 1959 ASME-ASLE Lubrication Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

Oil rings have now been used for the lubrication of bearings for over a century. Because of their simplicity, reliability, and low cost, they have been installed in a great variety of rotating machinery over this period. Applied initially in relatively low-speed equipment, their range of use has continually been extended up to present limiting journal surface speeds of about 3000 to 4000 fpm.

A series of tests was made with rings ranging from $2^3/_4$ to $16^1/_2$ in. ID and at journal speeds up to 4000 fpm. Correlation of the results provides means for calculating ring speed for any journal speed. Oil viscosity, ring weight and diameter, ring immersion, and journal diameter are taken into account.

From this calculated ring speed, oil delivery can then be estimated from equations incorporating the effect of oil viscosity and related operating factors.

Torque Produced by Misalignment of Hydrodynamic Gas-Lubricated Journal Bearings..59—Lub-3...By J. S. Ausman, Assoc. Mem. ASME, Autonetics, Division of North American Aviation Inc., Downey, Calif. 1959 ASLE-ASME Lubrication Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

In some applications of gas-lubricated journal bearings, the misalignment torque or angular stiffness of the bearing is of interest. For example, a very high angular stiffness is required for gyroscope rotor bearings in order to accurately define the spin reference axis direction. Misalignment torque is also important in the design of self-aligning journal bearings. Here one is interested in determining how much friction or torsional stiffness can be tolerated in the pivoting mechanism.

A perturbation analysis is used to find the torque generated by a misaligned journal bearing (or, equivalently, to find the angular displacement of a torque-loaded journal). Results are presented graphically in terms of nondimensional parameters.

The Effects of Atmosphere on Dry-Grinding Steel With Al_2O_3 Coated Abrasives..59—Lub-6...By E. J. Duwell and W. J. McDonald, Minnesota Mining and Manufacturing Company, St. Paul, Minn. 1959 ASLE-ASME Lubrication Conference paper (multilithographed; available to Aug. 1, 1960).

Grinding of metals is primarily a physi-

cal process, but the conditions which are created make possible the occurrence of a variety of chemical reactions.

The grinding of steel with coated abrasives creates fresh metal surfaces which rapidly react with oxygen in the atmosphere. This reaction decreases the coefficient of friction between the Al_2O_3 grits and the steel, resulting in a higher rate of cut for sharp cutting particles, and increased abrasive life for the coated abrasive.

Reactive forms of chlorine, sulfur, bromine, and a number of other group VIA and VIIA elements are more effective than oxygen in decreasing the coefficient of friction, and therefore yield an improvement over grinding in air, similar to that always taken advantage of when grinding in air rather than an inert atmosphere.

Effect of Hardness, Surface Finish, and Grain Size on Rolling Contact Fatigue Life M50 Bearing Steel..59—Lub-11... By R. A. Baughman, General Electric Company, Cincinnati, Ohio. 1959 ASME-ASLE Lubrication Conference paper (multilithographed; to be published in **Trans. ASME—J. Basic Engng.**; available to Aug. 1, 1960).

The effect of hardness, surface finish, and grain size upon the compressive rolling contact fatigue strength of M50 bearing steel has been studied.

Considerable testing on the RC Rig and statistical treatment methods have been included.

A mathematical expression relating these variables to life expectancy is presented and the optimization of these variables is discussed.

It is shown that bearing fatigue of M50 increases by increasing hardness and grain size, and decreasing surface.

The optimum life identified occurs at Rc 64 hardness, 1.5 RMS surface finish, and a grain size of ASTM 2.

Applied Mechanics

Nonlinear Creep Deformations of Columns of Rectangular Cross Section..59—A-1... By H. H. Bleich, Mem. ASME, Institute of Flight Structures, Columbia University, New York, N. Y.; and O. W. Dillon, Jr., The Johns Hopkins University, Baltimore, Md. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Creep deformations of columns of rectangular cross section are studied for the case of materials following the nonlinear law $\dot{\epsilon} = (1/E)\dot{\sigma} + \lambda\sigma^{\kappa}$.

The essential point of the paper is the following: The time rate of the curvature $\dot{\kappa}$ of an element of a bar loaded by a constant force P and an increasing bending moment $M(t)$ has bounds, which depend on P and on the instantaneous values of M and $\dot{M}$, but not M's history.

In combination with the collocation method, this permits the formulation of ordinary differential equations for upper and lower bounds on the deformations.

Closed solutions for the critical time are obtained for one bound, while the other requires numerical integration.

The bounds which are a function of the initial eccentricity are reasonably close and are presented in tables and graphs.

By qualitative reasoning it is further shown that the location of the actual critical time with respect to the two bounds is governed by the ratio of the column load P and the nominal Euler buckling load P_E of the column if it were elastic.

Impact and Moving Loads on a Slightly Curved Elastic Half Space..59—A-2... By A. C. Eringen and J. C. Samuels, Purdue University, Lafayette, Ind. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Two-dimensional Fourier transforms are employed to treat the two-dimensional dynamic problem of elastic half space having a slightly wavy boundary.

The various boundary curves considered include square and triangular bumps and holes, and sinusoidal and periodic boundaries.

The number of different types of surface loadings considered are: (*a*) Normal tractions and zero shear, (*b*) impulsive normal tractions and zero shear, (*c*) suddenly applied normal tractions and zero shear, (*d*) concentrated normal load and zero shear, (*e*) concentrated impulsive load and zero shear, (*f*) pulsating normal load and zero shear, (*g*) moving loads, (*h*) pulsating moving loads, (*i*) vertical and horizontal loads, (*j*) moving vertical loads. Stress and displacement components for special cases of the loads described in (*a*, *c*, *f*, and *g*) acting on a sinusoidal boundary lead to a solution which requires evaluation of a single indefinite integral. Closed-form results are given for a uniform pulsating pressure load.

Earth Motion Beneath a Prescribed Boundary Displacement..59—A-3... By R. C. Geldmacher, J. W. Dunkin, and R. L. Anderson, Purdue University, Lafayette, Ind. 1959 ASME Annual Meeting paper (in type; to be published in **Trans ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Material presented in this paper is the result of a theoretical and experimental study of earth motion beneath a prescribed boundary deformation done as a phase of an investigation of the support characteristics of subbase treatments beneath rigid pavements. It should be of interest to anyone planning to attempt to validate a rational analysis of earth motion beneath a prescribed boundary displacement or to anyone engaged in measuring the absolute deflection of a highway, landing strip, or similar structure by means of a device that requires a reference point in the earth.

The purpose of this study was to formulate and to validate experimentally a rational analysis of the motion of the earth beneath a prescribed boundary displacement.

The study was prompted by the results of a series of exploratory measurements of earth motion beneath a pavement deflected by vehicular loads. These measurements were made in an attempt to establish the errors involved in measuring rigid pavement deflections by means of rods anchored at various depths in the earth, and suggested that a rational analysis of the movement of the earth beneath a prescribed boundary displacement and an experiment planned in terms of such an analysis might be fruitful.

It was decided to formulate the problem in terms of a linear plane-strain model because of the simplicity of the theory in comparison to that of a three-dimensional model. Boundary conditions were chosen in terms of displacement. In this way the earth was separated from the pavement and could be treated as a separate simpler problem, obviating the need for such information as tire pressure, tire contact area, pavement geometry, and pavement properties. Difficulties developed, however, in trying to design a two-dimensional experiment and it is the opinion of the authors that any subsequent treatment of the problem should be three dimensional.

Stresses in an Ellipsoidal Rotor in a Centrifugal Force Field..59—A-4... By M. A. Goldberg and Michael Sadowsky, Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

This paper contains an exact solution for the stress distribution in an elastic ellipsoid rotating about a free axis.

The surface of the body is free from boundary stresses.

The stresses are expressed with the use of 12 coefficients which have been tabulated for 209 ellipsoids of different shapes.

General diagrams give the maximum values of stresses as functions of two shape ratios.

A Perturbation Solution of the Equations of Motion of a Gyroscope..59—A-5... By Robert Goodstein, Boeing Airplane Company, Seattle, Wash. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Solutions of the equations of motion of a balanced, frictionless gyro are outlined and results given for three problems:

1 Motion due to an impulse on the outer gimbal, with the gyro housing or case considered fixed.

2 Motion due to a sinusoidal torque applied to the outer gimbal, with the gyro housing considered fixed.

3 Motion due to a sinusoidal displacement of the gyro housing.

The method for obtaining solutions of the simultaneous nonlinear equations of motion is a form of the perturbation method. This method assumes solutions for the time variables as power series in a suitable small parameter of the problem. Substitution of the assumed series in the equations of motion and equating of like powers of the parameter yield relations for the coefficients of the assumed series. The results which are obtained in this paper are justified by their ability to yield values of the correct magnitude and variation with independent variables to verify experimental test results.

Elastic Flexible Cable in Plane Motion Under Tension..59—A-6... By Wen-Hsiung Li, The Johns Hopkins University, Baltimore, Md. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The motion and stresses of a non-Hookian elastic flexible cable in plane motion under tension are described with four simultaneous quasi-linear, partial differential equations which are totally hyperbolic.

The propagation of the longitudinal elastic waves and the transverse waves are described by the four characteristics.

From the characteristic equations, solutions for simple longitudinal waves and simple transverse waves are obtained for uniform Hookian cables.

The problem of an infinite string moved at one point with a constant velocity can be solved.

Solutions also have been obtained for the interaction of transverse and longitudinal waves with sharp fronts.

On the Plastic Flow of Coulomb Solids Beyond Original Failure..59—A-7... By A. W. Jenike, Mem. ASME, University of Utah, Salt Lake City, Utah; and R. T. Shield, Brown University, Providence, R. I. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Principles developed for rigid-plastic solids exhibiting Coulomb's properties are adapted to the analysis of flow beyond original failure.

A variable yield function is proposed to account for the changes of cohesion during flow and equations are evolved for the stress field in two dimensions.

It is shown that, while in the stress field an effective angle of friction larger than the actual angle of friction is mandatory for these materials, in the velocity field the materials can be assumed incompressible.

Thermal Stresses Owing to a Hot Spot in a Rectangular Strip..59—A-8... By C. W. Nelson, Mem. ASME, University of California, Berkeley, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The thermal stresses for the plane-stress problem of a circular hot spot in an infinitely long straight strip of rectangular cross section are derived by a Fourier integral approach.

The hot spot is located on the longitudinal center line of the strip, and its radius is such that the boundary of the hot spot is tangent to both edges of the strip.

The temperature may be any function of the radius within the hot spot and is assumed to have a constant value (zero) throughout the rest of the strip.

Numerical values are given for the stresses on the edges and both center lines of the strip for a particular case.

Forced Vibrations of a Circular Plate..59—A-9... By Herbert Reismann, The Martin Company, Littleton, Colo. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

A solution is presented for the response of a clamped, circular plate to the action of an arbitrarily placed, harmonically oscillating, transverse, concentrated force.

The method may be extended to a variety of loading and boundary conditions and can also be applied to ring-shaped plates.

A Photoelastic Approach to Transient Stress Problems Employing Low-Modulus Materials..59—A-10... By J. W. Dally, Assoc. Mem. ASME, W. F. Riley, and A. J. Durelli, Assoc. Mem. ASME, Armour Research Foundation, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The objective of the program discussed in this paper was to develop a method, using photoelasticity and low-modulus materials, for studying dynamic stress distributions.

Early in the program a number of low-modulus materials were studied and Hysol 8705 (a urethane-rubber compound) was selected as the most promising.

A complete study of its mechanical and optical properties was made under static and dynamic loadings.

It was established that Poisson's ratio ν is independent of rate of loading, the stress fringe value $f\sigma$ is independent of rate of loading for strain rates greater than 8 in/in/sec, and both the modulus of elasticity E and the strain fringe value $f\epsilon$ were dependent on the rate of loading.

The specific energy loss for the material was about 10 per cent for the stress ranges associated with photoelastic determinations.

Experimental observations of photoelastic fringe patterns in a rectangular strut subjected to axial impact were made to illustrate the potential of the method.

Three different end conditions were imposed on the unloaded end of the strut: (*a*) A free end normal to the axis; (*b*) a fixed end normal to the axis; and (*c*) a free end inclined 45 deg to the axis. For the cases where the ends were normal to the axis it was found that the fringes followed the same law of reflection as the law for stresses given by elementary wave theory.

An Analytical Method for Locating the Burmester Points for Five Infinitesimally Separated Positions of the Coupler Plane of a Four-Bar Mechanism..59—A-11... By J. C. Wolford, Assoc. Mem. ASME, The University of Nebraska, Lincoln. Neb. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

A method is developed for analytically locating the Burmester points for the motion of the coupler plane of a four-bar mechanism through five infinitesimally separated positions.

The results of an example are compared with the results obtained by the graphical method of Müller for locating the Burmester points. The two methods are found to give essentially identical results.

Production of Rotation in a Confined Liquid Through Translational Motion of the Boundaries..59—A-15... By R. R. Berlot, Electro-Optical Systems, Inc., Pasadena, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The response of confined liquids to external driving forces is of interest in connection with the control of large liquid-propellant rockets in which the motion of the liquids is an important consideration in the stabilization of the autopilot. For stability analysis, it has been customary to neglect the nonlinear terms in the Navier-Stokes equation on the supposition that the motions to be

studied were infinitesimally small. It also has been assumed that the viscous terms could be dropped for the reason, as Lamb has indicated, that for slightly viscous fluids, the viscous effects are confined to a narrow region in the vicinity of the boundary.

In the course of experiments designed to check the linear inviscid theory, it was observed that, when a periodic linear motion was applied to the boundaries in a direction normal to the gravity vector, the liquid responded with an oscillatory motion about a single nodal line normal to the plane containing the gravity vector and the vector describing the linear motion of the boundaries, provided the driving frequency was sufficiently far removed from the natural frequency of oscillation. However, when the driving frequency was in the neighborhood of the natural frequency, the liquid departed from planar motion and a rotational wave was observed to wash around the boundaries. Upon cessation of the driving motion of the boundaries, it was observed, by dropping bits of paper into the liquid, that rotation was present.

The phenomenon is not predicted by linear, inviscid theory, and it is the purpose of this paper to indicate the mechanism whereby the rotation was produced in the liquid.

Stability of Forced Oscillations With Nonlinear Second-Order Terms ..59—A-19... By Chi-Neng Shen, Assoc. Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

A solution is obtained for forced oscillations with nonlinear second-order terms.

The stability of this solution is given by its variational equation.

The boundary of stability is analyzed by both the perturbation and continued fraction methods.

The amplitude of oscillation with damping terms is also determined by the iteration procedure.

Transient Analysis of Stress-Wave Penetration in Plates..59—A-16... By Norman Davids, The Pennsylvania State University, University Park, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

An analysis of the propagation of a transient stress pulse concentrated at a boundary of a plate whose thickness is of the order of a wave length is presented.

It is based on an expansion method used by Caignard in geophysical-layer problems which obviates the contour-integration difficulties and whose terms represent successively reflected waves of increasing time delay.

From the general formulas obtained in this paper for an arbitrary forcing function, the stress versus time distribution along the axis of a 1-in-thick aluminum plate is obtained for a 5-microsec exponentially decaying pressure pulse.

Inside the plate it is found there is a compressed zone which is relieved by a negative front traveling with the distortional wave velocity. When this interferes with a certain reflected negative front, the stress reverses in sign.

A comparison of the location of this reversal is made with those based on plane-wave assumptions. Limiting cases are discussed.

The Half Space Under Pressure Distributed Over an Elliptical Portion of Its Plane Boundary..59—A-17... By H. Deresiewicz, Mem. ASME, Columbia University, New York, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

In determining the safety of foundations the assumption is usually made that the pressure distribution on the ground, in general unknown, is closely approximated by a constant one.

Mathematically, the problem is thereby reduced to finding the components of stress and displacement in a half-space due to a uniform pressure on a portion of its plane boundary.

The paper contains an investigation of this problem for the case of load-

Hydraulics

A Study of Boundary-Layer Characteristics of Turbomachine Blade Rows and Their Relation to Over-All Blade Loss..59—A-23... By W. L. Stewart, W. J. Whitney, and R. Y. Wong, Lewis Research Center, NASA, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Results of a number of investigations concerned with the boundary-layer characteristics of turbomachine blade rows and their relation to the over-all blade loss are presented.

It is demonstrated that the over-all loss can be obtained from the momentum boundary-layer thickness.

The momentum boundary-layer thickness is in turn shown to be correlated by flow Reynolds number and total blade surface diffusion.

By assuming Zweifel's form of blade-loading diagram the total blade surface diffusion parameter can be determined as a function of blade solidity and reaction across the blade row. Thus this type of loss analysis enables an approximate predetermination of the over-all blade row loss as derived from fundamental boundary-layer concepts.

In addition, it shows the effect on over-all blade loss of varying such design features as solidity and reaction.

Flow Phenomena of Partially Enclosed Rotating Disks..59—A-49... By L. A. Maroti, Assoc. Mem. ASME, Ingersoll-Rand Company, Phillipsburg, N. J.; G. Deak, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass.; and F. Kreith, Assoc. Mem. ASME, Lehigh University, Bethlehem, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The flow of air in the space between a rotating disk and a stationary side wall placed parallel to its surface has been investigated over a range of Reynolds numbers from 3×10^5 to 6×10^6 at clearance-to-diameter ratios from 0.0125 to 0.0625.

When the size of the stationary side wall was larger than the diameter of the rotating disk the flow in the gap was found to be periodic; several distinct and separate inflow and outflow regions were observed to rotate in the same direction as the disk, but at a slower speed.

The number of flow regions was found to be a function of the disk speed and the gap size.

The frictional torque on the housing was also measured and the effect of source flow on the flow pattern was studied qualitatively.

Viscous Dispersion in Water Hammer..59—A-12... By M. L. Walker, Jr., Howard University, Washington, D. C.; E. T. Kirkpatrick, Assoc. Mem. ASME, University of Toledo, Toledo, Ohio; and W. T. Rouleau, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

When a column of fluid moving with uniform velocity is instantaneously stopped at the downstream end a pressure wave is propagated upstream.

In an inviscid fluid the wave is a step discontinuity, and the pressure so calculated serves as an easily obtained upper bound for all practical "water-hammer" problems, the exact solution of which may be either difficult or impossible to obtain.

This paper describes an analysis of

ing over an area bounded by an ellipse.

Two of the results are: (*a*) On the normal to the loading area through its center, the two principal stresses in planes parallel to the undeformed surface, compressive on and near the surface, become tensile within a depth smaller than the length of the corresponding principal axis of the loading area; (*b*) the normal deflection of the surface is greater at the extremity of the minor axis of the loading area than at the extremity of the major axis, the difference between the two values increasing with the ellipticity of the bounding curve.

Coupled Torsional and Longitudinal Vibrations of a Thin Bar..59—A-18... By R. C. Di Prima, Rensselaer Polytechnic Institute, Troy, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The effect of pretwist on the natural frequencies of coupled torsional-longitudinal oscillations of thin bars is studied.

It is found that the natural frequencies of oscillations which consist primarily of torsional motion may be considerably increased depending upon the thinness of the bar, and the amount of pretwist.

The natural frequencies of oscillations which consist primarily of ongitudinal motion are not significantly altered.

viscous dispersion in relation to the upper bound.

The conclusion is reached that in problems of practical interest the bound is not significantly changed by the dispersive effects of viscosity.

Design of Suction Piping and Deaerator Storage Capacity to Protect Feed Pumps..59—A-20... By R. S. Thurston, Assoc. Mem. ASME, Cornell University, Ithaca, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The effect of transient suction pressure decay on a centrifugal boiler feed pump has been under study.

Using concepts established by these authors, this paper presents an analytical method for determining the minimum permissible weight of water ratio between the deaerator storage tank and the suction piping to the boiler feed pump.

With sufficient capacity this tank can insure against flashing at the pump's suction, thereby avoiding cavitation and vapor binding of the pump.

Power

Material Considerations in Superheater Design..59—Pwr-11... By P. M. Brister, Mem. ASME, and G. N. Emmanuel, The Babcock & Wilcox Company, Barberton, Ohio. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

It is well recognized in the power industry that the most efficient power-generating units are those using high superheat and reheat temperatures. The more heat that can be put into a unit of steam by superheating, and then reheating, the more efficient the cycle becomes. To obtain this high superheat and reheat, metals that can operate at high temperatures and will not deteriorate or fail in service must be used.

It is the purpose of this paper to review the principal factors involved in superheater design, and to show how material considerations are the governing factors in establishing the maximum temperatures that can be used economically for generating power today.

Calculating the maximum superheater tube metal temperature is probably one of the most difficult phases of superheater design. An accurate prediction of this temperature is necessary in order to select the proper material and the thickness for the superheater tubes. If too many safety factors, or too much conservatism is used, the material may be unnecessarily expensive, and the tube thickness too great.

Some of the more important factors which must be considered by the designer are:

1 High temperature strength.

2 Surface stability (resistance to corrosion and oxidation).

3 Structural stability (resistance to microstructural changes as a result of service conditions).

4 Fabrication requirements (capability of materials to be hot-worked, cold-worked, and joined by commercially feasible methods).

5 Material cost versus power-plant economics.

Operation of Steam Turbines to Minimize Shell Cracking..59—Pwr-10... By S. B. Coulter and R. L. Jackson, General Electric Company, Schenectady, N. Y. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Analysis of the inspection records of over 800 turbines shipped by the authors' company in the last 20 years shows that there is a definite relationship between the type of service operation and shell cracking, with the highest incidence of cracking occurring where frequent starting and loading cycles are encountered without development of proper procedures to minimize thermal stresses. There also is evidence that turbines with higher steam conditions are more susceptible to cracking due to their heavier metal sections. With the trend towards more frequent starting and loading cycles and higher pressure and temperature turbines being delegated to this type of cyclical service, the development of procedures and devices to minimize cracking has become imperative.

Procedures for reducing turbine shell cracking are described in this paper. These methods fall into two main classifications: (*a*) Those for turbines yet to be built where improved mechanical designs can minimize the effects of thermal changes, and (*b*) those for the large number of units already in service where generally the only means available are the development of improved operating procedures and the application of accessories to control shell-temperature differentials.

Although cracking is caused by the thermal cycling of the unit, the prevalence of cracking is most closely related to the unit operating temperature. Very little cracking has occurred for units rated 600 F and below; a progressively higher incidence of cracking has been occurring at operating temperatures above 600 F.

There does not appear to be any very definite difference in the resistance to cracking of any of the various ferritic-shell materials used to date.

Differences in mechanical design have been of less importance than the type of operation and control of steam temperature; however, records do indicate that 360 degree admission, and provisions for flexibility to accommodate differential expansions, are definitely beneficial. One very successful design, used up to the present time on the smaller rated turbines and now being extended to the larger rated units, has the cast-nozzle port passages so arranged as to be free of the main bulk of the horizontal joint.

Economics and Design of Montrose Steam Electric Station..59—Pwr-9... By F. A. Ritching, Assoc. Mem. ASME, and W. E. Slemmer, Ebasco Services, Inc., New York, N. Y. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Factors leading to the decision to install a mine-mouth steam-electric generating station remote from the consumer area to be served are discussed in this paper. Also discussed are the design considerations for the Montrose Steam Electric Station of Kansas City Power and Light Company.

The Montrose site was selected on the

basis of a comprehensive study involving all factors of future load growth, fuel availability and cost, and site considerations; and was selected since it provided for the lowest over-all energy cost to Kansas City Power and Light Company's system.

Adequate fuel reserves are available and have been dedicated to the requirements of the Montrose plant.

The plant includes no novel or untried features and the design is the most economical for the prevailing conditions.

The total investment cost of the plant, together with transmission facilities, will be substantially less than estimated.

Peaking—A Definition of the Problem..59—Pwr-6...By R. W. Dodson, Mem. ASME, Southwestern Electric Power Company, Shreveport, La. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

The peaking problem manifests itself in different ways in different parts of the country. Companies operating in the northern part of the United States normally have their annual peaks in the early evening of the short days of December. In some cases, companies serving heavily populated urban areas experience an abnormal peak of two or three weeks duration resulting from Christmas lighting superimposed on their normal peak.

In the semitropical climate of certain parts of the south, little residential heating is necessary. The easiest and simplest way to take the early morning chill out of a home is with the addition of a few electric radiant heaters. Occasionally, a cold wave will appear for a few days and most of these heaters will be placed in service with a resulting peak on the utility.

Certain of our western states depend on water power for a large part of their generating capacity. Every few years they are confronted with the problems of adverse water flow and consequent loss in capacity. While this is a loss in capacity rather than an increase in load, the effect is about the same.

From the earliest days of the electrical industry the variation in load imposed by customers has posed operating problems to electric utilities. At first, the use of electricity was largely confined to lighting which caused a sharp peak in the early evening that tapered off to little or nothing in the early morning hours. The widespread use of electricity today has created further variations in loads of a seasonal nature.

It is the purpose of this paper to examine the reasons for the growth of short-duration peak loads and to define the need for peaking generating equipment.

Steam Power Plants for Peaking Service..59—Pwr-8...By A. R. Lebailly, Mem. ASME, Sargent & Lundy, Engineers, Chicago, Ill. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

In the South the rising summer load has outpaced the growth of winter load and has required extensive expansion in generating facilities. Often this situation is accompanied by a decreasing system annual load factor. Other sections are faced with the same problem to a lesser degree, but there still remain short-duration peaks to satisfy.

Power companies have two possible solutions: They may continue to add larger and more efficient base-load units and operate previous units at the decreasing load factor; or they may provide for growth by staggering high-cost efficient units for high load factor service with units of lower cost primarily designed for reduced load factor, or even install special units intended only for peak shaving service and low annual operating hours.

The latter consideration is the subject of this paper.

Development of a Power Test Code for Steam Turbines Including a New Procedure for Simplified Performance Tests..59—Pwr-7...By O. D. Whiddon, Assoc. Mem. ASME, The Detroit Edison Company, Detroit, Mich. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

When an ASME Power Test Code is revised, at least two areas are considered for improvement. Current test techniques, instrumentation, and equipment to be tested are reviewed by the Test Code Committee. Appropriate changes are made to modernize the new code to meet present needs. The code may also be improved by a change in basic structure.

Power Test Code No. 6, Steam Turbines, is being revised to include improvements in both areas. This Code was issued originally in 1915. Since that time it has been revised and reissued three times. The current revision, the fourth, was formally initiated at a reorganization meeting of Power Test Codes Committee No. 6 in New York on Nov. 30, 1956.

Fifteen Years' Experience Employing Simplified Performance Tests to Follow Plant Efficiency..59—Pwr-5...By F. H. Light, Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Simplified plant-performance tests have been used by the author's company for fifteen years to detect changes in turbine efficiency, and also, when a significant change is indicated, further analysis is made to find the cause of the change.

This paper presents some examples of the practical application of this program. In later years, this method has been extended to cover boiler and condenser performance as well.

Studies are in progress to use automatic data-collecting devices and digital computation to utilize this approach on a continuous basis instead of dependence on monthly samples.

The more rapid detection of the cause of efficiency changes may justify the cost of automatic equipment.

"Bench-Mark" Testing in Industrial Plants..59—Pwr-4...By L. J. Brown, Mem. ASME, E. I. du Pont de Nemours and Company, Wilmington, Del. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Test procedures used in the author's company vary greatly from plant to plant because of the wide difference in size and complexity of these plants.

Similarly, because of the smaller size of the power equipment, tests are conducted on a less extensive scale than in utility plants. However, ASME Power Test Codes are followed as closely as possible within the limitations of cost and field conditions.

The results of the tests are used for acceptance of equipment and for future design. The test data are used as "bench-marks" by plant operators in routine daily checks of individual pieces of equipment and by plant engineers for development of power-plant standards from which monthly or more frequent over-all power-plant performance efficiency is determined.

With the use of computers there is a broader horizon for quicker, more accurate, and less costly control of industrial power-plant performance based on bench-mark test data.

The Power Mine and Coal for Montrose Station..59—Pwr-3...By J. J. Jones, Mem. ASME, Peabody Coal Company, Chicago, Ill. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Combination of a large utility generating station located adjacent to a coal field and the operation of a strip mine for only one customer is relatively new in the Middle West. This paper describes the equipment and operation of the Peabody Coal Company which supplies fuel to Montrose Station of Kansas City Power and Light Company.

The first unit at Montrose will consume approximately 500,000 tons annually and the second unit now under construction an additional one-half million tons per year.

Machine Design

Synthesis of Epicyclic Gear Trains Using the Velocity Ratio Spectrum..59—A-22... By R. C. Brewer, The Imperial College of Science and Technology, University of London, London, England. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

For a simple epicyclic train, the controlling element is almost invariably fixed i.e., prevented from rotating by being connected, in some way, to the frame.

Such trains are easy to synthesize because there are a limited number of variations of the three basic elements and, normally, six equations will define all possible velocity ratios. For a compound epicyclic train, the number of equations is considerably increased.

A method of synthesizing compound epicyclic trains is developed using the concept of a velocity ratio spectrum. To facilitate the application of this concept, only one train in a compound epicyclic train is regarded as basic; all others are considered as merely serving the purpose of modifying the motion of the controlling element in the basic train.

Dimensionless Parameters for Helical Compression Springs..59—A-30... By R. J. Erisman, International Harvester Company, Melrose Park, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

Spring design, in many instances, is still a trial and error process.

The underlying reason is the large number of complex variables which must be related to the allotted space which the spring will occupy and to the desired loads throughout the working range.

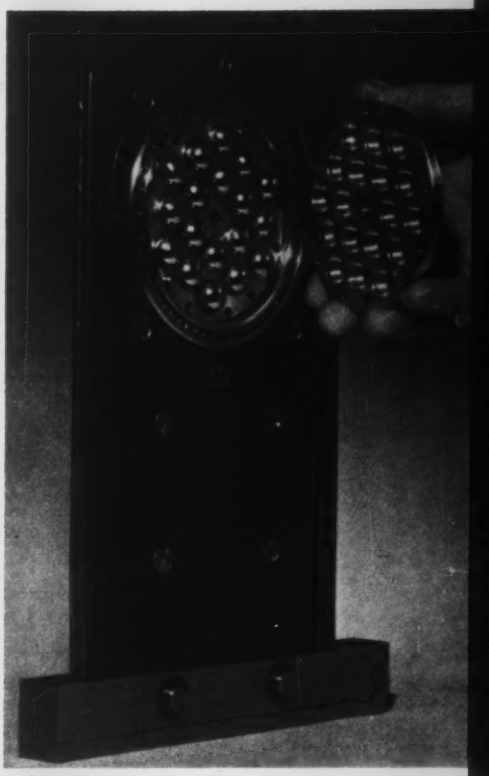
This paper presents a system of parameters which enables the spring designer to graphically portray these variables for a given problem. Derivations are based on the total number of coils as well as the outside diameter which accurately defines the entire space required for the spring. Charts are presented for springs with two dead coils and a torsion modulus of 11,500,000 psi.

Inertial Effects in a Multiple-Ball Transmission..59—A-14... By W. S. Rouverol, University of California, Berkeley, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

A new type of mechanical variable-speed transmission, which owes its improved efficiency and wear-life to the utilization of multiple point contacts in pure rolling, has a power capacity in proportion to the maximum tractive forces and rolling velocities developed by a large number of small steel balls.

Designing for maximum power capacity depends on finding the point at which the components of tractive force arising from inertial effects at high speed become so large as to interfere with the proper kinematic action of the balls.

Consideration is given to the influence of a number of design and operating parameters, such as ball diameter, cage diameter, cage velocities, and velocity ratio.



Key element of multiple-ball variable speed drive: A rotatably supported cage in which numerous balls are housed in spherical journal seats. When pressed between the faces of two disks at a point displaced from either axis, this element enables the balls to roll without sliding on both disks and to transmit power from one disk to the other with minimum frictional loss. (59—A-14)

A description of the coal seams at the mine is given. The electrical power required for the operation of the mine is noted. Stripping equipment, pit operation, coal loaders, trucks, the transfer point, and railroad cars for the operation are treated in some detail.

High-Temperature Alloy Considerations in Steam-Turbine Designs..59—Pwr-12... By N. L. Mochel, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME-AIEE National Power Conference paper (multilithographed; available to July 1, 1960).

Application of ferritic and austenitic materials in steam turbines involves many considerations, and these become more complex as temperatures reach higher levels. Naturally, the strength properties, load carrying ability, creep rates, creep rupture, are of primary importance.

Stronger materials at any level of temperature permit maintaining reduced-wall thicknesses, better designs, greater flexibility, and greater temperature uniformity, with greater freedom from thermal gradients. But with this greater load-carrying ability, one cannot overlook the importance of good ductility, and freedom from notch-sensitivity.

Materials must be stable. There must be a minimum of structural change at temperature, over long periods of time, that would permit undue loss of strength or ductility. There must be some kind of stability, freedom from distortion, warping, bowing, and the like. Thermal expansion in mating parts and assemblies is most important consideration where fits or clearances are involved. Thermal conductivity is another important consideration, and damping also is an important item in turbine blading.

A general discussion of these considerations is presented and areas in which solutions to specific problems have been achieved are noted.

Fuels

Fireside Corrosion of Superheater Reheater Tubing..59—Fu-5... By James Jonakin, Mem. ASME, and J. T. Reese, Combustion Engineering, Inc., New York, N. Y.; and G. A. Rice, Assoc. Mem. ASME, Electric Energy, Inc., St. Louis, Mo. 1959 ASME-AIME Solid Fuels Conference paper (multilithographed; available to Aug. 1, 1960).

Joppa Steam Electric Station consists of six boilers and turbines with the necessary auxiliary equipment. The hourly peak generating capacity is 1,050,000 kw. The yearly coal consumption for 1958 was approximately 3,149,000 tons. It is an outdoor type, natural-circulation, tangentially-fired, reheat unit designed to produce 1,200,000 lb per hr of steam at 1055 F with a maximum drum pressure of 2150 psig. The unit was designed primarily for firing Southern Illinois and Western Kentucky bituminous coals.

This is a base-loaded station operating around the clock, seven days a week at maximum capacity. Fireside corrosion

is being experienced in the superheater and reheater. Corrosion is not localized to either side of the furnace but occurs across the entire width. However, it is limited to certain depths through the finishing superheater and reheater and has occurred to varying degrees on both ferritic and stainless-steel alloy tubing. The corrosive action differs between the ferritic and stainless-steel materials.

This paper describes tests performed to determine the corrosion rate of stainless-steel alloys. Studies to determine the mechanism by which constituents of the coal ash adhere to the tubes and how the deposits cause corrosion are also noted. Formation of deposits and of corrosive compounds in deposits are also discussed.

Use of Bench Scale Tests to Predict Combustion Performance of Coals..59—Fu-3...By E. A. Zawadzki, Bituminous Coal Research, Inc., Pittsburgh, Pa., and Felix du Breuil, Bituminous Coal Research, Inc., Columbus, Ohio. 1959 ASME-AIME Solid Fuels Conference paper (multilithographed; available to Aug. 1, 1960).

Testing of coals in full-scale equipment to obtain performance data is both costly and time-consuming.

Results from an investigation of the plastic and swelling properties of a series of bituminous coals, varying in rank and combustion properties, indicate that a reliable bench-scale test procedure can be developed for evaluating various coals for use in full-scale combustion equipment.

Performance data from full-scale combustion tests have been correlated with data from currently used bench-scale tests and a specially-designed test furnace having a one-foot-square grate.

This paper reports the design and development of this test furnace, presents the results obtained to date, and discusses the significance of bench-scale tests in the prediction of the combustion performance of coals.

Factors to Consider in the Use and Application of Industrial Coals..59—Fu-2...By U. B. Yeager, Mem. ASME, Island Creek Coal Sales Company, Huntington, W. Va. 1959 ASME-AIME Solid Fuels Conference paper (multilithographed; available to Aug. 1, 1960).

Many factors are involved and must be considered in any adequate appraisal of a coal for power-plant uses.

There are three basic considerations that must first be made: (*a*) The fuel itself; (*b*) the equipment with which the fuel is to be used and the uses for which its consumption or alteration is intended; and (*c*) the personnel and the extent of their capabilities and training in using the coal with the equipment at hand for the uses intended.

Coal evaluation, proper application, "use values," and "incremental costs" are each treated. Coal characteristics and their effects are discussed in relation to sulfur content of the coal, washed coals, grindability, coal handling, maintenance, and such.

Survey of Carbonizing Properties of American Coals...59—Fu-1...By D. E. Wolfson and G. W. Birge, Bureau of Mines, U. S. Department of the Interior, Region V, Pittsburgh, Pa. 1959 ASME-AIME Solid Fuels Conference paper (multilithographed; available to Aug. 1, 1960).

The Coal Carbonization Section was established in 1928, when the Bureau of Mines, in co-operation with the American Gas Association, began a survey of carbonizing properties of American coals. A test method was developed, which has become known as the Bureau of Mines-American Gas Association or BM-AGA test.

The test is large enough to produce products that are in general similar to those obtained in large plants and in quantity sufficient to permit analyses and tests of quality to be made, yet the quantity of coal per charge is small enough to keep it within laboratory scope, make it convenient to operate, and permit reproducible control of test conditions. Furthermore, all ranks of coal from lignite

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports, not preprinted or published, were presented at ASME Meetings. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 50 cents per page. Microfilm copies are available at a cost of $2 for 40 pages or fraction thereof.

The following papers recently have been placed on file in the Engineering Societies Library:

1959 ASME Aviation Conference

Liquid Transfer Media for Airborne Thermal Systems, by K. K. Tang, K. T. Chang, and J. L. Mason

1959 American Power Conference

Evaluation of Coal Sampling Procedures, by W. W. Anderson

Generating Station Coal Bunker Explosions—Their Cause and Prevention, by W. W. Hegnauer and K. W. Hamming

Producing Lightweight Aggregate From Boiler Slag, by H. L. McNally

1959 ASME Metals Engineering Conference

Ceramics Made from Glass, by S. D. Stookey

Future Challenges of the Design Engineer to the Metals Engineer, by G. B. Warren

1959 Design Engineering Conference

Engineering Design in Germany, by H. Walter

1959 Bicentennial Conference of the Pittsburgh Section

Air-Pollution Problems and Their Solution in a Pulverized Coal Burning Steam Generating Station, by C. C. Munn and C. R. Adamson

1959 Production Engineering Conference

Statistical Process Evaluation as a Management Tool, by J. M. Brown

Untapped Sources of Productivity, by L. R. Cook

Manufacturing Challenges, by R. M. Critchfield

Can You Plan on Continuous Improvement in Productivity? by G. W. Jernstedt

Economics of Numerical Control, by E. E. Kirkham

Numerical Control for Machine Tools, by H. L. Palmer

In-Process Inventories, by J. H. Roseboom

The Use of Digital Computers as a Tool in Product Engineering, by C. W. Swift

1959 ASME-AMHS Materials Handling Conference

Integrating the Outbound Carrier Into the Production Line, by C. W. Boyce

1959 ASME Semi-Annual Meeting

Tires and Tire Cords, by G. M. Sprowls

1959 Nuclear Engineering and Science Congress

The Design of a Daniels-Boyd Nuclear Steam Generator for a 400-MW (Net E) Power Plant, by W. Boyd, J. A. Paget, and P. Hamel

Sodium Corrosion as a Function of Time, by J. M. McKee

The Potential of Organic-Cooled Heavy-Water Reactors for Economic Power Generation, by M. J. McNelly

Stress Analysis of the Junction Between a Support Skirt and Pressure Vessel, by R. F. Wojcieszak

to low-volatile bituminous can be carbonized by this method. The effect of such variables as bulk density, temperature of carbonization, preheating, rate of heating, blending, and size consists of coal can be, and have been, determined.

The purpose of this paper is to describe the apparatus and procedures used in this survey, the type of data obtained, and examples of their usefulness.

ASME TRANSACTIONS

The November, 1959, issues of the Transactions of the ASME—*Journal of Heat Transfer and Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members; $3 to nonmembers) —contain the following:

Journal of HEAT TRANSFER

Vol. 81 • Series C • No. 4

253 Dynamic Response of Heat Exchangers Having Internal Heat Sources—Part III, by V. S. Arpaci and J. A. Clark. (58—SA-39)

267 Heating and Cooling Air and Carbon Dioxide in the Thermal Entrance Region of a Circular Duct With Large Gas to Wall Temperature Differences, by Helmut Wolf. (59—SA-15)

280 Turbulent Flow in a Circular Tube With Arbitrary Internal Heat Sources and Wall Heat Transfer, by R. Siegel and E. M. Sparrow. (59—SA-19)

291 Laminar Condensation Heat Transfer on a Horizontal Cylinder, by E. M. Sparrow and J. L. Gregg. (59—SA-13)

297 The Use of Thin Films for Increasing Evaporation and Condensation Rates in Process Equipment, by E. L. Lustenader, R. Richter, and F. J. Neugebauer. (59—SA-30)

308 Some General Considerations of the Heating of Satellites, by A. J. Eggers, Jr., T. J. Wong, and R. E. Slye.

315 The Penetration of Planetary Atmospheres, by Carl Gazley, Jr. (59—Av-27)

323 Thermodynamic Properties of Helium at Low Temperatures and High Pressures, by D. B. Mann and R. B. Stewart. (59—HT-19)

327 Radiation Fin Efficiency for One-Dimensional Heat Flow in a Circular Fin, by R. L. Chambers and E. V. Somers. (59—HT-8)

Journal of ENGINEERING FOR INDUSTRY

Volume 81 • Series B • Number 4

281 Dynamic Problems Associated With Satellite Orbit Control, by B. W. Augenstein. (59—Av-4)

289 Study of Machinability of Metals, by H. Takeyama and E. Usui. (58—A-161)

293 Four-Bar Linkages—Approximate Synthesis, by W. W. Worthley and R. T. Hinkle. (59—A-130)

301 A Theory for the Effect of Mean Stress on Fatigue of Metals Under Combined Torsion and Axial Load or Bending, by W. N. Findley. (58—A-61)

307 An Analysis of Critical Stresses and Mode of Failure of a Wire Rope, by W. L. Starkey and H. A. Cress. (58—A-63)

317 An Application of Statistics to the Dimensioning of Machine Parts, by M. F. Spotts. (58—A-44)

323 The Dynamic Analysis and Design of Relatively Flexible Cam Mechanisms Having More Than One Degree of Freedom, by R. C. Johnson. (58—A-192)

332 Power Heat Balance Considerations in Design and Operation of Industrial Plants, by J. I. Hudson. (58—A-166)

339 Influence of Hot and Cold Storage-Loads on the Refrigerated-Space Temperature of a Cooling Complex, by C. F. Kayan. (58—A-165)

348 Development and Uses of a New Line of Vibratory Feeders and Unit Vibrators, by A. F. Israelson. (59—SA-33)

353 A Mechanical Time-Delay Device Sensitive to Centrifugal Fields, by J. R. Baumgarten, R. Cohen, and A. S. Hall, Jr. (59—SA-9)

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Note: No digests are made of ASME papers published in full or condensed form in MECHANICAL ENGINEERING.

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COMMENTS ON PAPERS

External Deposits and Corrosion in Boilers and Gas Turbines

Comment by R. C. Corey[1] and A. A. Orning[2]

THE author of this paper[3] set himself to an extremely difficult task: To summarize and evaluate a phase of combustion technology that is not only large, but also replete with contradictions, misconceptions, and lack of experimental data of a fundamental nature. It is inevitable, therefore, that certain points would be missed. Thus we are offering this supplement to his paper.

Concerning the mechanics of deposit growth: Something even more basic should be emphasized, namely, the mechanics of deposition itself. The author ascribes deposit growth to the physical and chemical behavior of particles in the gas stream. While certain types of deposits may involve deposition of discrete particles, there are other types that appear to be formed by condensation and reaction on relatively cold surfaces of inorganic vapors in the furnace gases. The adherent, and often corrosive alkali-metal type of deposits that occur on furnace, superheater, reheater, and boiler tubes appear to fall in this category.

We are not entirely satisfied with the idea that chlorides in coal per se are involved in deposition and corrosion. While there are numerous instances of a good correlation between the chloride content of coals and the tendency toward fouling deposits on heat-transfer surfaces in boilers, we believe the chloride content is largely a convenient indicator of the alkali-metal content of the coals which is the primary factor. Incidentally, the Bureau of Mines recently included the determination of the chloride content of several per cent of some 10,000 coal samples it analyzes yearly in connection with the Federal coal purchases. Perhaps, these data will eventually enable us to correlate furnace fouling in a systematic manner, as the British have done so successfully. We might add, however, that the maximum allowable chloride content for trouble-free operation of boilers may not coincide with that established by the British, owing to basic differences between American and British coals.

Some investigators have placed a great deal of emphasis on catalysis in connection with the conversion of SO_2 to SO_3 and appear to have overlooked the possibility that catalysis may not be a significant factor. The experimental work we have examined in connection with the catalytic oxidation of SO_2 to SO_3 beyond the flame boundaries is inconclusive and misleading. This may account for disappointing results from supplying certain additives with the coal or directly to the furnace, for the purpose of coating so-called catalytic surfaces and inhibiting or delaying the rate of conversion to SO_4.

We are in agreement with the author on the following points:

(*a*) The calculated dew point of flue gases, based on the system SO_3-H_2O, is of limited value in boilers, since more complex systems are usually involved. The system SO_3-H_2O-Na_2O is a case in point. Determining the dew point of flue gas yields information that is of little or no use in predicting fouling and corrosion of economizers, preheaters, and the like. If dew-point apparatus duplicated or simulated closely the conditions that prevail at surfaces undergoing corrosion, they would be useful for testing purposes, but the efforts to date in this direction have been unsuccessful.

(*b*) The use of tertiary air at certain critical points in a boiler or a turbine might alleviate the problems associated with deposition and corrosion. This was demonstrated conclusively in the early forties in connection with the external corrosion of furnace-wall tubes in certain slag-tap units, when air supplied through the casing in furnace-wall areas that had been subject to severe tube corrosion brought about a marked reduction in boiler outages to replace damaged wall tubes.

(*c*) The development of metallic coatings that will resist chemical attack, for certain applications, is not an insurmountable task. This is witnessed by the successful use of aluminum-coated tubes in resisting attack of furnace tubes by alkali-metal sulfate deposits.

[1] Chief, Division of Solid Fuels Technology, Region V, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa. Mem. ASME.

[2] Chief, Combustion Section, Branch of Bituminous Coal, Bureau of Mines, U. S. Department of the Interior, Pittsburgh, Pa. Mem. ASME.

[3] B. A. Landry, "External Deposits and Corrosion in Boilers and Gas Turbines," MECHANICAL ENGINEERING, vol. 81, June, 1959, pp. 70–73, condensed from Paper No. 59—A-208.

Zytel Spur Gears

Comment by A. H. Burr[4]

THE authors of this paper[5] report the results of a large number of endurance tests, and they are to be complimented on their work. This kind of test is a lengthy one, and so one seldom finds as much data in one paper.

Since the observed failures are attributed to fatigue, one might expect the form and dimensions of the fillets at the tooth roots to be of some importance. In metal gears the corresponding stress-concentration factors are quite significant. The writer would be interested in knowing more about the fillets for

[4] Professor in charge, Department of Machine Design, Cornell University, Ithaca, N. Y. Mem. ASME.

[5] K. W. Hall and H. H. Alvord, "Zytel Spur Gears," MECHANICAL ENGINEERING, May, 1959, vol. 81, pp. 50–53, condensed from Paper No. 58—A-209.

both the molded and the cut teeth and why they were not considered significant. Can the lower life of the cut gears be attributed to a smaller fillet?

In the design of metal gears it has been common to use a velocity factor to account for impact caused by tooth deflection and spacing errors. With a much more flexible material it might be expected that the effect of spacing errors would be minimized. The design factors suggested in Table 2 are adjusted for velocity only by using one value below a certain speed and a slightly lower value above that speed. However, Fig. 4 of the paper indicates a very definite effect of pitch-line velocity upon life at a given nominal calculated stress. Is this to be attributed entirely to rubbing velocities and the effect upon Zytel of the heat thus developed?

No tests are reported for speeds above 3730 fpm. How were the design factors determined for velocities above 4000 fpm?

Comment by G. C. Kent[6]

The article[5] was of great interest and contained valuable information. However, the authors neglected to mention the greatest negative factor affecting the use of nylon gears, namely, their dimensional instability under changing temperature and humidity conditions.

It has been my experience that when a nylon gear is heavily loaded, and mounted in an enclosure, the generated heat will expand the diameter thus causing binding and quick ultimate failure.

In light-loaded applications with 48 pitch gears the most difficult problem was the control of center distance between gears due to variations in pitch diameter under varying ambient temperature and humidity conditions encountered during storage of the device and due to differences in pitch diameters of the gears as molded and fully moisture conditioned.

The authors' comments on the foregoing remarks would be very much appreciated.

[6] Engineering supervisor, Soreng Division, Control Company of America, Schiller Park, Ill. Mem. ASME.

Designing for Numerical Control

Comment by R. J. Render[7]

Too many engineers have been frightened away because of the words "numerical control" and a few foreign terms that have been applied to such systems. This paper[8] vividly points out that when the flourish and glamour are removed from the subject it again resolves itself down into basic engineering fundamentals which we have all been using for many years. This same philosophy, perhaps, should be extended beyond the machine design to also the control-system design. The control engineers have proved to us over the past several years that the accuracies, flexibility, and usefulness of such systems make them worth while. It is, however, now up to the other people in the engineering profession to expand on this concept and direct its future to provide more reliable, more rugged, and easier to maintain control systems and machines.

The other contribution that this paper makes is stimulation of the imagination of what such machines can mean to us now and in the future in our design and manufacturing thinking. It will be pretty revolutionary to be able to think of producing small and intermediate-sized runs at little or no extra costs from large lots.

[7] Staff Supervisor, Vickers, Inc., Electro-Hydraulic Systems, Detroit, Mich.

[8] Robert K. Sedgwick, "Automation Approach Using Numerical Control," MECHANICAL ENGINEERING, vol. 81, May, 1959, pp. 62–63, condensed from Paper No. 58—A-288.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Inventor-Engineer-Scientist

Edison

By Matthew Josephson. McGraw-Hill Book Company, Inc., New York, N. Y., 1959. Cloth, 5¼ × 9 in., illus., Introduction, references, index, xii and 511 pp., $6.95.

Reviewed by Glenn R. Fryling[1]

WHY should mechanical engineers read biography? Professional calling undoubtedly has little to do with choice of this literary form, and the person trained in liberal arts probably finds the biographers' accounts of the famous and infamous interesting for the same reasons that technical graduates do. But this new and intensely fascinating biography of Edison should have an especial appeal to ASME members. By actual count of this reviewer, the outstanding American exponent of the art of inventing made technical contributions to the fields of 16 of the 24 Professional Divisions of the Society.

What manner of man was this? The author, a skilled biographer of individuals ranging from Zola and Stendhal to Sidney Hillman and "The Robber Barons," had access to hitherto unavailable material in the form of laboratory records and correspondence at the Edison Laboratory National Monument in West Orange, N. J. From direct study of this information and from other authentic sources he has succeeded in dispelling some of the myths about Edison (some of which the inventor had himself promoted during his lifetime) and in portraying his strengths and shortcomings in an appealing yet objective manner. The author has done all of this within a framework of technical accuracy that should satisfy the most critical tastes.

Edison emerges in two guises, to both of which the adjective "incredible" is applicable: a man of versatility whose

[1] Editor, *Combustion Engineering*, Box 157, Princeton Junction, N. J. Mem. ASME.

accomplishments add up to a series of paradoxes.

Let us look first to his versatility. Mechanical engineering is generally considered one of the broadest engineering disciplines, incorporating many specialties, some of which are only tenuously related to one another. Yet the technical interests of Edison in the field of mechanical engineering alone encompassed two thirds of the present ASME Professional Divisions. These ranged from his last researches in the field of rubber and plastics to his earliest inventions in what is now known as machine design. On the journey between, to name but a few, his activities took place in such obvious fields as power and instruments and regulators, but equally of importance, in the subject matter of Professional Divisions as widespread as materials handling, management (where he was a pioneer in the entire concept of research-laboratory organization and operation), safety, railroad, and process industries.

Or consider his accomplishments in electrical engineering, where subjects related to power are generally considered in a different realm from those related to communications. Here Edison made substantial improvements to both components and circuitry used for telegraphic and telephonic communication.

A few years later he used this knowledge of the characteristic behavior of electrical circuits to great advantage when he conceived the complete central-station power-generating system that made his invention of the incandescent light an outstanding long-term commercial success. Beyond applied engineering, Edison had an intuitive understanding of physics and chemistry and keen powers of observing new phenomena of nature. This final example of versatility shows the same man who was to engage in such visionary engineering projects as the mass prefabrication of concrete-shell houses and the beneficiation of low-grade iron ore serenely working in his laboratory making detailed notes of what scientists later termed the Edison effect, one of the most important antecedents of modern electronics.

Running through this biography of Edison are many paradoxes: The small boy who could not get along in school and was largely instructed by his mother to learn for himself, but who grew up to hire PhD's to assist in his laboratory; the highly intuitive inventor who could keenly observe physical phenomena and find practical applications in apparatus, but who had an indifference approaching distrust of the work of mathematicians and theoretical physicists, even when they became his colleagues; the founder of industries as diversified as manufacture of electric lights, streetcars and electric locomotives, dictating machines, instruments, and chemicals, but who never remained identified with any of them for an extended period; the sensitive individual who was deeply and lastingly hurt when his name was dropped from Edison General Electric Company but who engaged in a campaign of personal villification against George Westinghouse for championing alternating current in opposition to the Edison direct-current system; the dedicated inventor-engineer-scientist who was also a master of public relations and did much to promote his inventions through skillful exploitation in the press; the simple country boy who made good in the big city but remained without constraints and airs and never outgrew the enjoyment of playing practical jokes, even on his most distinguished friends; the man whose passion was inventing and who went through several fortunes in pursuit of this objective, all in preference to what might have been a later life of ease; and, last of all, the innovator of the industrial research laboratory and the last of the great individual inventors who, wittingly or unwittingly, thereby established the role of the industrial research team and perceptibly diminished the contributions of future lone-wolf inventors.

But what was Edison really like? This reviewer when but a very small boy was reportedly held in the lap of the great inventor, the occasion being his visit to Sunbury, Pa., to unveil a plaque commemorating his invention and first installation of the three-wire electric lighting system. In this atmosphere tales, however mythical, of Tom Edison, the juvenile printer and chemical experimentalist who had read all of the books in a Detroit library, made a lasting impression of an inventive hero who, too, had grown up in a small town. Then came high school and the study of physics under a teacher who had been associated with Edison. If nothing else, one then learned that Edison had personal qualities that made his former employees forever hold him in near-worshipful awe.

The author confirms these personal impressions as he pictures Edison, in his latter years, enjoying the personal adulation that was his whenever he visited places where he had worked earlier.

The biographer likewise gives many indications of the qualities of loyalty that Edison inspired in his associates. To this reviewer, then, this is verifiable evidence that the author succeeded in creating a true image of Edison in authentic settings.

One word of caution in concluding: Do not plan to read this biography of Edison unless you have some leisure time in prospect. If there is a mechanical engineer anywhere whose interests are completely divorced from this rewarding and inspiring biography, let him step forward and be counted.

The Nimonic Alloys
By W. Betteridge. 1959, St. Martin's Press, Inc., 103 Park Avenue, New York 17, N. Y. 332 p., 6 × 9¼ in., bound. $15. The search for alloys capable of showing strength and creep-resistance under extremely severe conditions of temperature and stress led to work on the nickel-chromium system which culminated in the development of precipitation-hardenable alloys of the "Nimonic" series. This volume is intended as an introduction to these alloys and as a reference book. The information given deals mainly with the metallurgical characteristics of these alloys and their mechanical and physical properties as well as with suitable methods of treatment and handling. Manufacturing and processing techniques have been discussed only briefly, and when they are relevant to properties and uses.

BOOKS RECEIVED IN LIBRARY

Oihydraulik: Grundlagen und Anwendung
By E. M. Chaimowitsch. Second Edition. 1958, VEB Verlag Technik, Berlin, Germany. 331 p., 7 × 9½ in., bound. 32.80 DM. This German translation from the Russian covers the fundamentals and applications of oil hydraulics. New mathematical concepts of certain hydraulic phenomena are considered, and the applications to automated operation are presented in detail with illustrations of the equipment and circuits involved, particularly for machine-tool work.

Organization for Production
By E. S. Roscoe. 1959, Richard D. Irwin, Inc., Homewood, Ill. 525 p., 6¼ × 9¼ in., bound. $8.10. A survey of modern industry and scientific management, which is intended to acquaint readers with their operating principles. The various activities of the manufacturing enterprise are covered, including manufacturing methods and equipment, financing, general accounting, and the human factors involved. Appendixes include case problems, a glossary of terms, and a selected bibliography.

Power Plant Theory and Design
By P. J. Potter. Second Edition. 1959, The Ronald Press Company, New York, N. Y. 710 p., 6½ × 9½ in., bound. $10.50. A revised

edition of the author's "Steam Power Plants" that covers the entire range of power-generating equipment, with particular emphasis upon the steam plant as the basic element. While giving principal attention to large central power-station design, the book also discusses the smaller industrial plants, as well as gas, hydroelectric, and nuclear plants. Recent advances are given in the design of such equipment as cyclone furnaces, pressurized boilers, and demineralizing equipment. The economic aspects of equipment selection receive increased emphasis and the proper selection of pipe sizes, insulation thickness, heater-terminal differences, and station pressures and temperatures are fully discussed.

Problems and Solutions. Vol. 2
By C. E. Harrington. 1959, Published by the author, 45 Elk Street, Springville, N. Y. 138 p., $8^1/_2 \times 11$ in., paper. $2.75. A review of the material which is likely to be contained in parts 2 and 3 of the New York State Professional Engineering Examinations. Many of the problems usually asked in these examinations have their counterpart presented in this volume which covers the period from 1955 to 1958. Little attempt is made to answer descriptive problems, but rather to answer those problems which have a mathematical solution.

Professional Creativity
By E. K. Von Fange. 1959, Prentice-Hall, Inc., New York, N. Y. 260 p., $5^3/_4 \times 8^1/_2$ in., bound. $4.95. The present volume is the result of Creative Seminars held by the General Electric Company for its professional personnel. The first part is intended to give insight into the creative process by showing what creativity is, and how to utilize mental powers and resources to the fullest extent to create ideas. The latter part discusses in detail the planning of creative work to insure that worth-while objectives are established, that the creative work, itself, is conducted efficiently, and that the results, when achieved, will be accepted by others.

Registrierinstrumente
By Albert Palm. Second Edition by H. Roth and E. G. Schlosser. 1959, Springer-Verlag, Berlin, Germany. 255 p., $6^1/_2 \times 9^1/_2$ in., bound. 27 DM. A survey of recording instruments used in science and industry. It covers instruments with typical or special properties and those of commercial importance. The five main sections deal, respectively, with registering or tracing means; driving mechanisms; transcription of test data; descriptions of instruments, both mechanical and electrical; and a brief treatment of applications.

The Scientific Revolution
Edited by G. W. Elbers and Paul Duncan. 1959, Public Affairs Press, Washington, D. C. 280 p., $6^1/_4 \times 9^1/_4$ in., bound. $6. A long-term assessment of the challenge created by the scientific revolution which the satellite launchings symbolized. The authors open with a discussion of this scientific revolution and its implications for the United States, move on to an appraisal of the problems faced in developing a science program adequate to the nation's needs, and then evaluate the role of science in society and the effect of a lack of public understanding upon science and the scientist. The concluding sections examine the adequacy of the educational system in providing the human resources needed.

Solid State Magnetic and Dielectric Devices
Edited by H. W. Katz. 1959, John Wiley & Sons, Inc., New York, N. Y. 542 p., $6 \times 9^1/_4$ in., bound. $13.50. An account of solid-state devices and components using ferrites and titanates. The book begins with a classical treatment of magnetization and polarization and then proceeds to show the general application of these principles to electromechanical devices, small signal devices, ferrites at microwave frequences, magnetic and dielectric amplifiers, digital techniques employing square loop materials, magnetic recording, and magnetic and dielectric measurements. Appendixes discuss specialized aspects of the subject such as reciprocity in linear systems, magnetoresistance, and parametric devices.

Studies in the Mathematical Theory of Inventory and Production
By K. J. Arrow, Samuel Karlin, and Herbert Scarf. 1958, Stanford University Press, Stanford, Calif. 340 p., 7×10 in., bound. $8.75. The general mathematical concepts behind efficient inventory and production control are presented in a series of interrelated papers. Beginning with the background of modern inventory theory and the nature and structure of inventory problems, the book continues with discussions of the deterministic and stochastic inventory processes. Several new concepts are developed, including that of the operating characteristics of an inventory policy and that of the stationary solution of an inventory problem. These concepts are particularly suited to solution of inventory problems when the determination of optimal policies is extremely difficult.

Symbolic Logic and Intelligent Machines
By E. C. Berkeley. 1959, Reinhold Publishing Corporation, New York, N. Y. 203 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. The principles, methods, and purposes of symbolic logic and Boolian Algebra, on which the programming of computers and some other machines is based, are explained. The material on symbolic logic contains a considerable amount of comparisons and examples, as does the discussion on machines. The design of both small and large machines are presented, along with the specific problems involved. The programming of automatic computers and complex devices such as robots completes the book.

Symposium on Basic Mechanisms of Fatigue
Published 1958 as Special Technical Publication No. 237 by the American Society for Testing Materials, Philadelphia, Pa. 121 p., $6 \times 9^1/_4$ in., bound. $3.75. Papers discussing the mechanisms of failure such as dislocations, internal friction, crystalline and structural changes, and surface disintegrations. In addition to clarifying the mechanisms leading to fatigue damage, the papers emphasize the statistical nature of the material behavior under cyclic loadings.

Symposium on Radioactivity in Industrial Water and Industrial Waste Water
Published 1958, as Special Technical Publication No. 235 by the American Society for Testing Materials, Philadelphia, Pa. 69 p., $6 \times 9^1/_4$ in., bound. $2.50. Because of the advent of nuclear power, new problems have been created in the field of industrial water techniques. Papers are presented which discuss problems in the reactor plant itself and in the associated water waste. Methods of analysis are described which include those for radiation hazards.

Thermodynamics
By Gordon J. Van Wylen. 1959, John Wiley & Sons, Inc., New York, N. Y. 567 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.95. The fundamental laws and terms of thermodynamics are presented from an engineering perspective. Topics discussed include the first and second laws of thermodynamics; entropy; ideal gases; availability, irreversibility, and efficiency; reciprocating machines; power and refrigeration cycles; flow through nozzles and blade passages; thermodynamic relations and equations of state; combustion; equilibrium. Tables of thermodynamic properties are included in an appendix.

Warmebehandlung der Eisenwerkstoffe
By Heinrich Ruhfus. 1958, Verlag Stahleisen M.B.H., Düsseldorf, Germany. 483 p., $6^3/_4 \times 9^1/_4$ in., bound. 46.80 DM. This text on the heat-treatment of ferrous materials is primarily intended to help the heat-treater or design engineer in selecting the best method and equipment for a desired quality. In addition to the practical information on methods and installations, the book also covers the basic theory on the crystal structure of iron. There is an extensive bibliography, but all titles are given in German regardless of the original language.

ASTM Standards on Wood, Wood Preservatives, and Related Materials
Published, 1959 by the American Society for Testing Materials, Philadelphia, Pa. 446 p., 6×9 in., paper. $5.50. Sixty-nine standards covering methods for establishing structural grades for wood and timbers, evaluating mechanical and physical properties of wood, methods of chemical analysis, fire tests, tests for panels for building construction, truss assemblies, and glued joints.

Aerodynamik des Flugzeuges. Vol. 1
By H. Schlichting and E. Truckenbrodt. 1959, Springer-Verlag, Berlin, Germany. 455 p., $6^3/_4 \times 9^1/_2$ in., bound. 52.50 Dm. This first volume of a series under the above title, "Aerodynamics of Airplanes," contains the section on fluid mechanics fundamentals, including hydrodynamics, gas dynamics, and boundary layer theory. It also contains part 1 of the aerodynamics of the wing, dealing with the wing of infinite span in incompressible flow (profile theory). While the present volume is devoted to the theory of aerodynamic forces, vol. 2 will take up the movements of the airplane under the action of these forces.

Air-Pollution Control
By W. L. Faith. 1959, John Wiley & Sons, Inc., New York, N. Y. 259 p., $6^1/_4 \times 9^1/_2$ in., bound. $8.50. Presents the basic factors that should be considered in any air-pollution control program. Beginning with an explanation of the effects of air pollution and the importance of meteorological variables, there follows a discussion of the nature and source of the more common air pollutants. Detailed consideration is then given to methods of determining the amounts of various contaminants in the air, the most appropriate means of controlling emissions at the source, and the legal means available for control. Newer aspects such as the automobile exhaust problem and the hazards of radioactivity are also discussed.

Analysis of Linear System
By David K. Cheng. 1959, Addison-Wesley Publishing Company, Inc., Reading, Mass. 431 p., $6^1/_4 \times 9^1/_4$ in., bound. $8.50. A detailed presentation of the two essential steps involved in the analysis of a linear physical system: the setting up of the mathematical equations that describe the system in accordance with physical laws, and the solution of these equations subject to appropriate initial or boundary conditions. In the formulation of the equations that describe a physical system, emphasis is placed upon electrical circuits. To deal with systems other than electrical, a chapter on analogous systems is included which

treats in detail methods for drawing electrical circuits analogous to linear mechanical and electromechanical circuits. The Laplace transform method of solving linear differential and integrodifferential equations is stressed.

Analysis of Pipe Structures for Flexibility
By John Gascoyne. 1959, John Wiley & Sons, Inc., New York, N. Y. 181 p., $7^1/_2 \times 10^1/_2$ in., bound. $7.50. Because of the hazards that accompany high-pressure and high-temperature piping systems, analysis of pipe structures for stress and flexibility has assumed more importance. Aspects of this problem discussed are codes and standards, methods of stress calculation, the elastic-center method of stress calculation, and pipe supports. Typical problems are worked out in detail.

Annual Review of Nuclear Science. Vol. 8
Edited by Emilio Segrè and others. 1958, Annual Reviews, Inc., Palo Alto, Calif. 417 p. 6 × 9 in., bound. $7. Collection of papers surveying recent developments within the field of nuclear science. Such topics are covered as invariance principles of nuclear physics, the optical model, hyperfragments, antinucleons, gamma-ray spectroscopy by direct crystal diffraction, primary cosmic radiation, radioactivity of the atmosphere and hydrosphere, geochronology by radioactive decay, nuclear astrophysics, cellular radiobiology, and information theory in radio-biology.

Automation and Society
Edited by H. B. Jacobson and J. S. Roucek. 1959, Philosophical Library, Inc., New York, N. Y. 553 p., 6 × $8^1/_2$ in., bound. $10. Various aspects of automation are reviewed in this collection of papers which examine the present and potential impact of automation on society. Topics presented include the evolution of automation, its application to critical industries in the American economy, the challenges of automation, and the problems it raises in the areas of education, leisure, politics, and business and public administration. The final paper by two Russian authors gives a picture of automation in the Soviet Union. A glossary of automation terms and 37 short case histories are also included.

Calcul à la Rupture et Plasticite des Constructions
By A. R. Rjanitsyn. 1959, Éditions Eyrolles, Paris, France. 284 p., $6^1/_4 \times 9^1/_2$ in., bound. 4400 fr. This translation from the Russian deals with the calculation of the breaking points of structures based on the theory of plasticity. The elastic limits of both statistically determinate and indeterminate structures are defined, as are the laws of linear and nonlinear deformation under different types of stress. Essential theory is given for calculating the plastic limits of beams, plates, etc.; and the book concludes with the general principles for determining tolerances and safety coefficients in construction work.

Circuit Theory of Linear Noisy Networks
By H. A. Haus and R. B. Adler. 1959, John Wiley & Sons, Inc., New York, N. Y. 79 p., 6 × $9^1/_4$ in., bound. $5. Discusses a method of determining the single-frequency noise performance of an amplifier and its optimization. The properties of linear noisy networks that are invariant under lossless network transformations are analyzed. These invariants are determined for multiterminal-pair networks, and their physical interpretations in terms of a generalized "available power" are presented. The invariants are then considered for the special case of a linear two-terminal-pair amplifier, and are shown to establish a lower limit on its noise performance. Various ways of achieving this limit are presented for all classes of amplifiers, including those with negative resistance.

Control Engineering
By G. J. Murphy. 1959, D. Van Nostrand Company, Inc., Princeton, N. J. 385 p., 6 × $9^1/_4$ in., bound. $7.50. Modern automatic control theory is covered at an intermediate level. Following a discussion of time response, including a development of Laplace transformations, the characteristics of a large number of control-system components are described, and design in the complex domain covered. The use of frequency-response techniques, a complete treatment of a-c carrier systems, and the analysis of systems with time lag are then presented, and followed by sampled-data systems and the statistical analysis of linear control systems. Concluding sections deal with nonlinear control theory and the use of describing functions and the phase plane.

The Corps of Engineers: Troops and Equipment
By The U. S. Army, Office of the Chief of Military History. 1958, U. S. Government Printing Office, Washington, D. C. 622 p., $7^1/_4 \times 10^1/_4$ in., bound. $4. An account of the manner in which the traditional tasks of American military engineers changed and new ones developed in response to the tactical and logistical demands of World War II. Among the many means used by the Corps of Engineers to adjust to the new vehicles and weapons used were the adoption of powerful earthmoving machinery, portable bridges of greater capacity, landing mats to substitute for paved airfields, and mapping instruments to exploit aerial photography. The volume is based on intensive research into the voluminous records of the Corps of Engineers, and constitutes one of the volumes in the series "United States Army in World War II."

A Diderot Pictorial Encyclopedia of Trades and Industry
Edited by C. C. Gillispie. Two Vols. 1959, Dover Publications, Inc., New York, N. Y. Both volumes $9^1/_4 \times 12^1/_4$ in., various pagings, bound. Vol. One—$10. Vol. Two—$10. Set $18.50. A selection of 485 plates taken from Diderot's "L'Encyclopedie, ou Dictionnaire Raisonné des Sciences, des Arts, et des Métiers." The plates provide an extensive record of the state of manufacturing and of various trades in France just prior to the Industrial Revolution. The major activities are illustrated in sequences which carry them right through from raw materials to finished product. Methods of casting, forging, grinding, and stamping are all shown, as are the manufacture of metal articles of all kinds from cannon to cutlery.

Diesel Engine Catalog. Vol. 24
Edited by Rex W. Wadman. 1959, Diesel Progress, Los Angeles, Calif. 428 p., $10^1/_2 \times 13^1/_2$ in., paper. $10. Descriptions, specifications, and illustrations are provided for equipment made by diesel engine, supercharger-turbocharger, fuel injection, governor, transmission, and diesel engine accessory manufacturers.

Elsevier's Dictionary of Building Construction in Four Languages
By C. J. Van Mansum. 1959, D. Van Nostrand Company, Inc., Princeton, N. J. 471 p., $6^1/_4 \times 9^1/_4$ in., bound. $15.75. Nearly 8500 terms used in the building trade by contractors and architects are listed on an English alphabetical basis, and cover building materials, tools, and technical expressions. The corresponding terms in French, Dutch, and German are then given, arranged horizontally across the page. For each language there is an alphabetical list of words referring to the corresponding English term.

Energy for Man
By Hans Thirring. 1958, Indiana University Press, Bloomington, Ind. 409 p., $5^1/_2 \times 8^1/_2$ in., bound. $6.95. A long-range, nontechnical survey of the production of energy for man's use and the problems arising from the ever-increasing need for power in our technological civilization. The author discusses the major prime movers for power generation and the fuel involved; in addition, he considers solar energy, atomic energy, and nuclear reactors, thermonuclear reactions, and heat pumps, with brief mention of wind, tidal, and geothermal power.

Engineering and Organization
By Everett Laitala. 1959, Richard D. Irwin, Inc., Homewood, Ill. 391 p., $6^1/_2 \times 9^1/_2$ in., bound. $7.20. The goals of engineering are defined and the standards by which its performance can be evaluated are established. The greatest portion of the book is concerned with the place of the engineering process within the over-all structure of an industrial enterprise, and discusses such aspects as management, product specification, budget, design, production, selling, buying, maintenance, and personnel. The author is primarily concerned with fundamental principles as a basis for establishing standards, rather than with present-day practice.

Concise Dictionary of Science
By Frank Gaynor. 1959, Philosophical Library, Inc., New York, N. Y. 546 p., $5^3/_4 \times 8^1/_2$ in., bound. $10. Concise definitions of terms and concepts pertaining to the various fields of science. In addition to the more standard terminology, coverage is given to the newer sciences of virology, cytogenetics, radio-chemistry, high-energy, and solid-state physics, etc.

Feedback Control Systems
By J-C Gille and others. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 793 p., $6^1/_4 \times 9^1/_4$ in., bound. $16.50. A synthesis of the field of servomechanisms that combines in a single volume a description of the over-all theory, both linear and nonlinear, and of the components used. The subject matter included falls into two categories, the first constituting a textbook on the basic theory of servomechanisms, and the second dealing with additional data on particular and more advanced methods. Special topics discussed are structural stability, transient response of servo with any nonlinear component, stability of nonlinear systems on the verge of instability, forced oscillations of nonlinear servos, Liapunov's direct method, and describing function with statistical input.

Heat Transfer and Fluid Mechanics Institute, 1959
Preprints of Papers.
Printed and distributed 1959 for the Institute by the Stanford University Press, Stanford, Calif. 243 p., 7 × 10 in., paper. Price unknown. Papers concerned with current, fundamental research. Sections included deal with rarefied gas flows; magnetohydrodynamics; fluid mechanics and heat transfer; ablation, mass transfer, and separation; new and unusual research. These constitute preprints of papers given at the Institute held at the University of California in Los Angeles.

Heat Transfer Engineering
By Hilbert Schenck, Jr. 1959, Prentice-Hall,

Inc., New York, N. Y. 310 p., 6 1/8 × 9 1/2 in., bound. $9.25. A unified approach to heat transfer based on two fundamental concepts: the first law of thermodynamics referred to as energy balance, and the various rate equations. The author discusses basic conduction theory; free convection; forced convection, including heat transfer in compact surfaces and to and from liquid metals; radiation between two or more bodies; and unsteady-state conduction in one, two, and three dimensional systems. Various applications are then considered such as the finned or extended surface, the simple boiler and condenser, and the heat exchanger in its various forms.

Helicopter Dynamics and Aerodynamics
By P. R. Payne. 1959, The Macmillan Company, New York, N. Y. 442 p., 6 1/4 × 10 in., bound. $17. A comprehensive treatment of helicopter theory from the viewpoint of the practicing aerodynamicist and project designer. Aspects discussed are induced aerodynamics, rotor dynamics, dynamics of rotors with hinge constraint, flapping stability and blade movements in gusts, stability and control, rotor vibration, ground resonance and vibration due to rotor resonance, control loads and vibration, blade flutter and rotor weaving, and blade flexing and resonance. A feature of the volume is the recent information on the cantilever, stiff-hinged, high flapping pin offset and other advanced forms of rotor.

Hypersonic Flow Theory
By W. D. Hayes and R. F. Probstein. 1959, Academic Press, Inc., New York, N. Y. 464 p., 6 1/4 × 9 1/4 in., bound. $11.50. Concerned with the problems of determining the details of the flow field about a body placed in a high-velocity gas stream. Following a general consideration of the subject, the authors continue with a discussion of the small disturbance theory, the Newtonian theory, constant-density solutions, the theory of thin shock layers, methods for solving blunt-body and locally supersonic flows, viscous flows and interactions, and free molecule and rarefied gas flows.

International Association for Bridge and Structural Engineering, Publications, 1958.
Published 1958 for the Association by Verlag Leeman, Zürich, Switzerland. 296 p., 6 3/4 × 9 3/4 in., paper. 38 DM. Papers dealing with such topics as analyzing deformations of plane trusses, general instability of low framed buildings, bending of a sectorial plate, stability of pony-truss bridges, stability of rib-reinforced cylindrical shells under lateral pressure, cyclic loading of portal frames, analysis of thin elastic shallow segmented shells, and a model continuous beam bridge with steel deck. Papers are written in English, French, and German with summaries of each paper in all three languages.

Linear Network Analysis
By Sundaram Seshu and Norman Balabanian. 1959, John Wiley & Sons, Inc., New York, N. Y. 571 p., 6 × 9 1/4 in., bound. $11.75. The foundations of network theory are developed in relation to steady-state and transient responses, time and frequency responses, and analysis and synthesis. Starting with basic fundamentals the authors continue with network synthesis, realizability conditions, and feedback and control systems. Specific aspects discussed include computation of network functions from any given real part, magnitude, for angle; integral relationships between real and imaginary parts; method of computing steady-state response for periodic driving functions; general treatment of classical filter theory; signal flow graphs from the point of view of directed graph theory.

LIBRARY SERVICES

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Linguistic and Engineering Studies in the Automatic Translation of Scientific Russian into English
Published 1959 by The University of Washington Press, Seattle, Wash. Various pagings. 8 1/2 × 11 in., paper. $10. A report on research done in the field of automatic language translation of scientific Russian into English. An extensive linguistic study of Russian literature was made in about forty scientific fields and resulted in the development of an operational lexicon of about 14,000 sematic units. This lexicon was prepared for use in a photoscopic memory device and translation system, developed by the International Telemeter Corporation. Part one is concerned with the linguistic analysis of the problem while part two is concerned with the engineering analysis.

Lubrication of Bearings
By E. I. Radzimovsky. 1959, The Ronald Press Company, New York, N. Y. 338 p., 6 1/4 × 9 1/4 in., bound. $10. The basic principles of bearing lubrication are presented, and the development and application of rational equations for bearing analysis is discussed. Inasmuch as true mathematical analysis can be applied only to bearings which operate under conditions of hydrodynamic lubrication, the major portion of the book is devoted to hydrodynamic theory and its application to bearing design. Some information is also included on hydrostatic lubrication, however. The application of theory to basic design problems is illustrated by a number of examples.

Machine Design Problems
By D. J. Myatt. 1959, McGraw-Hill Book Company, Inc., New York, N. Y. 186 p., 8 1/2 × 11 in., paper. $8.50. Problems intended to illustrate the application of the principles of mechanics, kinematics, mechanics of materials, metallurgy, and manufacturing methods to the design of machine elements and machines. Part one is concerned with the design of machine elements, and problems are so selected that a variety of approaches to their solution is required. The problems included in part two require the complete design of a machine, and call for an understanding of the behavior of one machine part in relation to the other parts in the machine.

Manpower and Innovation in American Industry
By S. E. Hill and Frederick Harbison. 1959, Industrial Relations Section. P. O. Box 248, Princeton, N. J. 85 p., 5 1/2 × 8 1/2 in., paper. $2. This study attempts to explain the expansion in utilization of executives, managerial personnel, engineers, and scientists as a function of fundamental economic forces operating in modern society. It concludes that the greater employment of high-talent manpower is the consequence of innovation and of the pace of progress in American industry, and that this trend will increase as the economic growth of America increases.

Molecular Science and Molecular Engineering
By A. R. Von Hippel. 1959, John Wiley & Sons, Inc., New York, N. Y. 446 p., 8 3/4 × 11 1/4 in., bound. $18.50. In this, the third and final volume in a series of modern materials research, the fundamental molecular properties of matter and their applications derived by molecular strategy are presented. Beginning with atoms and molecules, it continues with the behavior of charge carriers in gases, the formation and structure of condensed systems, dipoles and their spontaneous alignment in ferroelectrics and ferromagnetics, and ions and electrons in liquids and solids. Among the specific applications considered are gas-discharge and solid-state devices, the molecular concepts producing masers and memory systems, transducers, transistors, parametric amplifiers, and ion-exchange resins.

Package Design Engineering
By Kenneth Brown. 1959, John Wiley & Sons, Inc., New York, N. Y. 263 p., 6 × 9 1/4 in., bound. $8.50. Beginning with the basic fundamentals of static and dynamic mechanics, strength of materials, and stress analysis, the text continues with the design characteristics of the tension spring, rubber shear mount, solid cushioning, and canvas strap suspension systems. In addition, the peculiarities of corrugated, sheathed crate, plywood, and metal shipping containers are discussed, as are the engineering fundamentals and design application of dehumidification and pressurization, vibration, and package test instrumentation.

Die Pumpen
By Hellmuth Shulz. Tenth Edition. 1959, Springer-Verlag, Berlin, Germany. 248 p., 6 1/4 × 9 1/4 in., bound. 19.50 DM. A standard text covering the fundamental principles, design calculations, construction details, and examples of applications of centrifugal and reciprocating pumps, jet pumps, and steam injectors. The major change in this edition is the material added to the previously brief section on jet pumps.

Vacancies and Other Point Defects in Metals and Alloys
Published 1958 as Monograph and Report Series No. 23 by the Institute of Metals, London, England. 238 p., 5 3/4 × 8 3/4 in., bound. $6. A collection of papers that discuss point defects and the mechanical properties of metals and alloys at low and high temperature, the effect of lattice defects on some physical properties of metals, point defects near the surface of a metal, and point defects in relation to diffusion in metals and alloys and the mechanical properties of ionic crystals.

Werkstückspanner
By K. Schreyer. Second Edition. 1959, Springer-Verlag, Berlin, Germany. 408 p., 6 1/4 × 9 1/4 in., bound. 38.40 DM. General principles and detailed descriptions are given of all types of tool-holding devices used in machine-shop practice, with the exception of press-work. Practical aid for the designer and engineer is provided by some 1200 line drawings of tool-holding devices and methods. A brief chapter is included on materials for tool holders.

Current Engineering: Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

First International Symposium on Gas-Lubricated Bearings, October 26–28

THE first international conference among scientists and engineers in the field of gas-lubricated bearings was held in Washington, D. C., October 26 through 28.

This major Symposium, sponsored by the Office of Naval Research in co-operation with other interested government agencies (Air Force Office of Scientific Research, Army Engineer Research and Development Laboratories, Atomic Energy Commission, Bureau of Aeronautics, Bureau of Ordnance, Bureau of Ships, Maritime Administration, National Aeronautics and Space Administration, and Wright Air Development Center), and conducted by The Franklin Institute of Philadelphia, was intended to provide an over-all examination and critical review of gas-bearing technology.

The roster of Symposium speakers reflects the widespread interest in gas-lubricated bearings. In addition to papers describing some of the major U. S. developments, papers also were submitted from researchers in Rumania, Austria, Germany, France, Holland, England, and Japan. More than 450 representatives of industry and government attended the three-day meeting. The 20 papers that were presented covered three categories: Reviews of past work in the field, reports on current experimental programs, and discussions of theoretical studies.

Gas-Bearing Technology

Reviews of gas-bearing technology were presented by Prof. Dudley D. Fuller, Mem. ASME, of Columbia University and The Franklin Institute, S. Whitley of the UKAEA Capenhurst facility, M. Graneek and J. Kerr of the National Engineering Laboratory, East Kilbride, Scotland, and T. Sasaki and H. Mori of Kyoto University, Japan.

In the first paper of the Symposium, Professor Fuller pointed out the more noteworthy characteristics of gas bearings that render them extremely useful in many of the unusual and stringent applications that confront industry and government today. He reminds us that gases are stable over a wide range of operating temperatures and thus do not undergo changes of phase such as other lubricants which melt, freeze, vaporize, or decompose between the limits of temperature that are presently considered for industrial service and national defense.

Applications are being contemplated from about −450 to as high as 3000. Especially favorable for high-temperature operation is the fact that gases show an increase in viscosity as temperature rises.

Another important advantage of the gas-lubricated bearing, he reported, is that it avoids contamination of the surrounding environment. This is accomplished by using the process gas from the system as a lubricant for the bearings. In many types of machinery, the machines associated with nuclear reactors for example, even small amounts of leakage or seepage of conventional lubricants into the system might well contaminate and damage the entire system; here, it is especially important to use noncontaminating gaseous lubricants. Professor Fuller is to present this paper before the ASME Annual Meeting.

As an associated part of his paper, Professor Fuller announced that "A Bibliography on Gas-Lubricated Bearings" would be included in the published proceedings of the Symposium. This bibliography has been prepared by The Franklin Institute engineer E. B. Sciulli, member of research team that is carrying out an important gas-bearing program for ONR and the other agencies that sponsored the Symposium. (Copy of the bibliography is $2.50 and may be ordered from OTS, Washington 25, D. C.)

New Developments

Those who attended the meeting were given views into some interesting programs and new developments. H. C. Rothe of the Army Ballistic Missile Agency, for instance, revealed at the Symposium that the first American satellite was guided into orbit by a missile-guidance system that employed gas-lubricated bearings. This illustrates one of the prime features of these bearings—low friction. In instrument applications, such as gyroscopes, this is especially important. Other advantages are high operating speeds made practical by low friction, slight heat generation which removes the need for bulky cooling machinery. Limits on operating speed are now imposed by such factors as

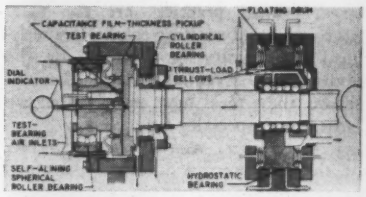
H. Blok, **left,** of the University of Technology at Delft discusses Symposium international coverage with Captain W. T. Sawyer, **center,** USN Office of Naval Research, and W. L. LePage, **right,** President of The Franklin Institute

mechanical strength against bursting or dynamic characteristics of the system itself.

Rothe went on to describe a relatively simple method for manufacturing gas bearings, a method that requires "no Swiss watchmakers." We infer that this method is to an extent responsible for our being able to incorporate high-performance guidance systems into our missile programs.

G. K. Fischer, Assoc. Mem. ASME, who, with J. L. Cherubim, Assoc. Mem. ASME, and O. Decker, described a study begun at Fairchild's Stratos Division and continuing at Analogue Controls, Inc., announced at the Symposium that a shaft-rotor system has been run on gas-lubricated bearings at a speed of 431,000 rpm. Current development work should raise this even higher.

Among the many high lights of the Symposium were papers presented by H. G. Elrod, Assoc. Mem. ASME, of Columbia University and consultant to FIL with coauthor A. Burgdorfer of Switzerland, and by M. Reiner of the Israel Institute of Technology. The Elrod-Burgdorfer paper described significant improvements the authors have been able to make on Katto and Soda's solution of the differential equation for an infinitely long self-acting journal bearing. Design charts based on the author's calculations were displayed. Reiner described experimental evidence he has obtained to indicate that air has non-Newtonian properties. This work of Reiner's is in the literature and has been disputed in print by Sir Geoffrey I. Taylor. Reiner concludes that a hitherto unknown effect permits gas bearings to support a load when the bearing surfaces are parallel and, at the same time, no air is supplied under pressure from an external pump. If further study bears this out, it would exclude hydrodynamic lubrication in fluid wedge bearings, and exclude hydrostatic lubrication.



Nemeth and Anderson apparatus, shown here, is used to test the behavior of 10-in-diam thrust bearings operating on externally pressurized air

Others who presented the results of their studies at the Symposium were: B. Sternlicht, Assoc. Mem. ASME, H. Poritsky, Mem. ASME, and E. B. Arwas, Assoc. Mem. ASME, of GE, on the dynamic stability aspects of gas-lubricated journal bearings; J. S. Ausman, Assoc. Mem. ASME, of North American Aviation, on the theory and design of self-acting gas-lubricated journal bearings including misalignment affects; W. A. Gross, Mem. ASME, of IBM, on numerical analysis of gas-lubricating films; N. Tipei and V. N. Constantinescu of the Rumanian Academia, on high-speed self-acting gas bearings; R. Comolet, University of Nancy, on radial flow of a compressible viscous fluid between parallel plates, and a theoretical study and experimental research on thrust bearings; A. Slibar of Stuttgart on the theory of the self-acting gas-lubricated journal bearing of finite width; H. Drescher of the Max Planck Institute on special features of self-acting gas bearings and their effect on practical applications; Z. N. Nemeth and W. J. Anderson of NASA on experiments with rotating 10-in-diam externally pressurized air-thrust bearings; J. H. Laub of JPL on evaluation of externally pressurized gas-pivot bearings for instruments; and G. R. Fox, Assoc. Mem. ASME, of GE and H. J. Sneck of RPI, on orifice flows in externally pressurized gas bearings.

Special features of the meeting were a banquet on the evening of the 27th, with guest speaker Peter Hackes, NBC Washington correspondent, who lightened the "burden" of technical papers schedule by describing the experiences of a reporter covering the Washington scene. The closing session of the Symposium consisted of a panel discussion of the papers. Professor Fuller chaired the discussion.

Proceedings of the meeting will be available for purchase in the near future. Inquiries should be addressed to: Gas Bearing Proceedings, The Franklin Institute, Philadelphia 3, Pa.

Asked whether the Institute plans to conduct another such meeting in the future, Institute spokesmen expressed the hope that within the next few years the group that sponsored this Symposium would be able to present a second international review of gas-lubricated bearing technology. The Franklin Institute itself will have a continuing interest in the field, both through the research program now being pursued by Institute staff members under the sponsorship of ONR and other agencies, and in other programs for both industry and government.

EJC-AIA Joint Committee Issues Progress Report

THE May, 1959, issue of MECHANICAL ENGINEERING reported the formation of an EJC-AIA Joint Committee to further develop and maintain appropriate relationships between engineers and architects. The Committee, meeting on a quarterly basis, established four subcommittees: Professional Liability, Division of Responsibility, Local Collaboration, and Fees. These Committees are actively at work and reported progress at the quarterly meeting of the Joint Committee on Sept. 9, 1959. The ASME representative to the Joint Committee, and the Society's representatives on the various Subcommittees, are all members of the Society's Professional Practice Committee.

G. I. Ross is a member of the Subcommittee on Fees. He reported to PPC a comprehensive review is being made of the various types of fees. Mr. Ross requested an alternate be designated to help share the work load. PPC has appointed F. E. Lyford as alternate.

J. K. M. Pryke is a member of the Subcommittee on Professional Liability. He reported the Subcommittee is meeting not only with engineers and architects, but also with contractors, and material and equipment vendors. The Subcommittee has an insurance man and a lawyer as consultants.

H. A. Naylor, Jr., Chairman of the Subcommittee on Division of Responsibility, reported the Subcommittee has broadened the scope of construction field from six to ten areas of work.

At the Sept. 9, 1959, meeting the Joint Committee reported that there was a great need for a Subcommittee on Legislation. Such a subcommittee was set up to look into national-level legislation of interest to both engineers and architects. The subcommittee will be available to advise on legislation at local levels. F. E. Lyford was designated to be the Society's representative on the new Subcommittee, which will be under the general chairmanship of J. P. O'Donnel, NSPE, of the Joint Committee.

The Joint Committee will welcome suggestions or comment from the membership of ASME. Such should be sent to the Society's representative, H. A. Naylor, Jr., 2 West Preston Street, Baltimore 1, Md.

Luring of Engineers, Piracy Hiring, High Turnover Charges Found Invalid . . .

CHARGES of "piracy" in the hiring of engineers, of fantastic turnover rates among companies that hire engineers, and of fabulous parties designed to lure them away from the competition are largely without foundation.

This is the conclusion of an extensive survey published in the Nov. 2, 1959, issue of *Product Engineering*.

Large and small companies, nationwide, that hire engineers—as well as placement facilities of engineering consultants, and others were questioned by the magazine, in an effort to pin down widely circulated reports of a chaotic situation in regard to engineers.

Less Than One in Ten. Engineers changing jobs next year, the survey reveals, will be less than one in ten. That one probably will make the change for a better working atmosphere, a more challenging assignment, rather than a phenomenal increase in salary or pie-in-the-sky promises.

Today's engineer, the survey found, is a rather substantial fellow who is looking for opportunity, growth potential, perhaps a private office, and a title. Once he finds a place that offers him approximately what he's after, he settles down, becomes active in his community, and isn't anxious to move. He shows no interest in hopping from one job to another, assuming he's kept reasonably happy where he is.

Top Men Always Scarce. Companies are expanding, and are always faced with the difficult problem of finding top engineers—those with exceptional ability and considerable experience. But by and large, ethical practices are the rule. Recruitment advertising emphasizes technical opportunity, not salary, or the idyllic life. Examination of the ads shows they seek men mostly for top positions in specialty fields.

J. R. Decker, western representative of the Engineering Societies Personnel Service, estimates that ten per cent of all engineers change jobs each year. In the 11-state area he serves, there are about 150,000 engineers; about 15,000 of them shift jobs each year, and about 1,500 use employment agencies. A survey of 387 companies by the Engineers Joint Council shows that turnover in industry in 1957 for all reasons was 11 per cent.

No Perfect Job. Companies say engineers have learned that there is no perfect job, and companies make a special effort to hire engineers they think are likely to stay, and then provide incentives for staying. The employment supervisor of a California company says one incentive is a growing company. Engineers in such a firm find many individual success stories there and realize that what others have attained also is possible for them. Variety of work and mobility within the company, fringe benefits, such as opportunity to participate in stock ownership and profit-sharing benefits, are other inducements.

Also contributing is a more realistic approach to interviewing. The applicant may be given a tour of the plant and his potential work area, a chance to talk informally with other engineers, without the boss present, so that he knows about what he will get before he decides.

Newspaper Advertising. Companies continue to use newspaper advertising, recruiting teams in major cities, suites at professional and trade shows, employment agencies, college visits, and word-of-mouth. Firms in the East find newspaper advertising especially effective. Persistent advertising keeps the company in mind and creates an image, so that when an engineer is ready to make a change, the company will come to mind. But instead of talking in glowing, but vague terms, ads now give facts: Job description, and community facilities, such as schools. Some companies attempt to solve recruiting problems by getting the young man early.

Companies reporting said recruiting costs averaged between $1000 and $15,000 annually. Some believed the cost could be cut by modernizing methods.

The charge of piracy is made less frequently. (When someone gets a man from you, it's piracy. When you get a man from someone else, it's honest American competition.) At least one West Coast aircraft company refuses to hire engineers who are employed by other aircraft firms. Recruiting at professional meetings is more subdued. Many societies—the ASME for one—prohibit recruiting in hotels where meetings are being held. Dignity and prudence now are the watchwords.

What Kind of Year Will 1960 Be for Business?

WHAT kind of year will 1960 be for business? The nation's leading economists think it will be a record-breaking year in most respects, but they are somewhat less enthusiastic about the outlook than they were a year ago.

This was the consensus of 273 of the nation's leading economists in business, government, and universities polled by F. W. Dodge Corporation, construction news and marketing specialists, in its annual survey of economists' opinions on the business outlook.

In releasing the results of the survey, Dr. George Cline Smith, Dodge vice-president and economist, said that the economists, on the average, expected the second half of 1960 to see some tapering off in the rate of growth, and that many expressed doubts about the 1961 outlook.

A sizable majority (65 per cent) expect total activity, as measured by Gross National Product, to rise steadily during the year, Dr. Smith reported. But, he pointed out, this was a distinct lessening of optimism from last year's survey, when 86 per cent forecast a steady rise during 1959.

The average expectation of the 273 economists participating in the current survey is that Gross National Product will reach an annual rate of $514 billion by the fourth quarter of 1960, a gain of 6 per cent over the mid-1959 level. The Federal Reserve index of industrial production is expected to rise 3 per cent from the mid-1959 level, reaching 160 by the end of next year. Over the same period, wholesale and consumer prices are estimated at one to 2 per cent higher.

The forecasts of most of the economists hinged upon a reasonably quick settlement of the steel strike. In addition, several other warning signs were mentioned. Among them the following are:

The labor situation. The economists frequently mentioned the question of other serious labor difficulties which may arise in the months ahead, particularly the possibility of a railroad strike.

The tight money situation.—with possible dampening effects on the economy in general, and on housing and plant expansion in particular.

Continued inflation. There was not much fear of runaway inflation, but the words "inflationary creep" seemed to characterize the general feeling.

Still . . . Scientists and Engineers Are Not Happy!

Scientists and engineers in American industry are anything but happy with their lot, Opinion Research Corporation reported recently.

Root of the problem: A fundamental, and unresolved, conflict between the scientific mind and the management mind.

The ORC study involved interviews with 622 scientists and engineers and 105 managers in six major companies deeply engaged in scientific research. The companies are in the aircraft, chemical, drug, electrical and electronic equipment, petroleum, and rubber industries.

The Grumble. Of the scientists and engineers interviewed, 72 per cent complained that management misuses their talents, 71 per cent maintained that their companies force them to overspecialize, and 67 per cent contended that getting ahead in management is more a matter of politics than knowledge.

Underpaid. One of the most sought-after professional groups in industry, 80 per cent of the scientists and engineers complained they were underpaid, when compared with others with similar training and responsibilities.

The study revealed a conflict between management's need to sell its products and make a profit and a basic quest for knowledge by the technical men. While 74 per cent of scientists and engineers interviewed listed sales and profits as primary goals of their companies, fewer than half said that they shared these goals.

No Green Pastures. In addition, 75 per cent complained that corporate pressures did not permit them the freedom "to work in their own way." They cited as obstacles demands for immediate results, schedules, budgetary considerations, and pressure to conform to established methods of problem-solving. One of the managers declared that "the place for such freedom is in academic institutions, not competitive industry."

The Conflict. It was found that scientists and engineers have a desire for status and freedom which is difficult to meet in a corporation and is more appropriate to private, professional practice, or university life. Also, technical men often fail to understand techniques and approaches used by management, such as managerial decision-making and the nature of risk taking.

Moreover, the study disclosed a lack of mutual respect on the part of management and technical groups, with each group tending to evaluate the other's accomplishments and rewards by its own standards.

Constructive Steps. Managers used to place greater emphasis on interpreting their everyday decisions to the technical man. More realism during college training and recruiting is also necessary so that the future scientist or engineer may know what to expect of corporate life.

On the other hand, Dr. Smith called attention to several specific features cited by the economists which might provide an additional upward push. These included:

A fillip to the economy after the steel strike, as industry tries to make up for lost time.

The need for further inventory build-up at least during the first half of 1960.

The prospects for a good automobile year.

The fact that 1960 is an election year.

In summary, Dr. Smith said, there is no question that the economists expect business to be good in 1960, with rising personal income, higher wages, and greater output in most industries. But, he added, the general impression seems to be that the boom will not have the buoyancy it had in 1959.

What About 1960?

Paul W. McCracken, professor of business administration at the University of Michigan, said before a session of the American Petroleum Institute meeting in Chicago, Ill., the nation's output of goods and services would reach a rate of $500 billion in 1960. He said the country was doubling its standard of living every 40 years.

Management's Responsibility

The American Management Association of New York City has published a 24-page pamphlet, "The Business Outlook for 1960," which reports opinions of government and industrial leaders on strength and weaknesses in the general economy for 1960, the 1960 sales forecast in key industry groups, and management's responsibility for legislation affecting business.

I. MECH. E. MEETINGS

Jan. 5–7, 1960

Symposium on recent mechanical-engineering developments in automatic control, I.Mech. E., London, England.

▶*Note:* The foregoing calendar of The Institution of Mechanical Engineers (Great Britain) meetings is published as a service to members of ASME. Further information relating to complete programs and available papers may be obtained from The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S. W. 1, England. Preliminary programs also are published in *The Chartered Mechanical Engineer* (I.Mech.E.) which is on file in the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y., and other libraries throughout the United States and Canada.

INDUSTRIAL FILMS

R and D at Work

Research and Development in cooperation with companies seeking to develop new commercial processes is the subject of a new 17-minute color film just released by The M. W. Kellogg Company, New York. The film is a brief, but complete, tour of Kellogg's laboratories and pilot plants, and it shows how integration among R and D groups increases total efficiency. Far from being simply a visual tabulation of equipment, this picture shows how an industry can obtain access to a broad process development pattern through co-operative research. By presenting the R and D groups at work: Planning, Exploratory, Process, Pilot Plant, Mechanical Engineering, and Chemical Engineering, the film shows how their functions can be applied to any stage of development work. The difference in points of view of client and Kellogg research groups acts as a catalyst to speed the creative process. In this philosophy, a client supplies the expertness in a specific field, Kellogg supplies a broad experience in a variety of processing fields.

Companies interested in exploring these services may borrow prints of the film, "Research and Development ah M. W. Kellogg," by writing Researct and Development, The M. W. Kellogg Company, 711 Third Avenue, New York 17, N. Y.

EDUCATION

$19.5 Million for Engineering

THE Ford Foundation will give grants totaling $19,500,000 to ten schools to modernize the teaching of engineering.

The grants, under the Foundation's new program for promoting scientific and engineering education, will be used to develop more imaginative courses and better faculties.

The largest, $9,275,000, will go to the Massachusetts Institute of Technology. Others are: California Institute of Technology, $3,200,000; Carnegie Institute of Technology, $2,250,000; University of California at Los Angeles, $1,200,000; University of Michigan, $1,175,000; Case Institute of Technology, $1,000,000; University of Illinois, $275,000; Purdue University, $275,000; Stanford University, $200,000; and the University of Wisconsin, $200,000.

In announcing the awards before the annual meeting of the American Institute of Consulting Engineers, Dr. Henry T. Heald, Mem. ASME, Foundation president, asserted that engineering education had fallen behind engineering developments.

"In the last two decades, a revolution has been under way in the practice of engineering," he said. "Yet, engineering education, the gateway to professional practice, has lagged behind.

"In a hopeless race against time and reality, most engineering students in their late teens and early twenties are being equipped for the engineering of the last half of the twentieth century by being indoctrinated with the art and practice of the Nineteen Fifties."

Dr. Heald emphasized that engineering education must be revised so as to impart "a thorough understanding of science and mathematics, their frontiers and how they may be applied to the needs of mankind."

More than half the grants are intended for recruiting qualified engineers for academic careers and strengthening faculties.

Fifteen professorships in engineering fields, including seven at M.I.T., will be created. In addition, faculty salaries will be improved, teaching and research fellowships set up and short-term residencies established at universities for outstanding engineers.

Standards Seminar

JOHN GAILLARD, Mem. ASME, consultant on industrial standardization, will hold his next five-day seminar on the subject in the Engineering Societies Building, 29 West 39th Street, New York 18, N. Y., from Jan. 25 to 29, 1960. The major purpose of his seminars is to assist top management in organizing the administrative setup and procedure for handling standardization work in the individual company, and training staff men in the functions of the standards engineer, including the art of writing specifications. So far, 405 men representing 226 organizations in the United States and five other countries have attended.

For details and registration, write to Dr. John Gaillard, 135 Old Palisade Road, Fort Lee, N. J.

AAAS Science Library

BEGINNING with the opening of school in September, the American Association for the Advancement of Science made available to 100 selected schools an Elementary School Science Library. The library consists of 100 carefully chosen books on science and mathematics for children in the first to sixth grades and will be circulated without charge. The new project will run concurrently with the successful five-year-old Traveling High School Science Library Program.

It was organized primarily because investigations carried on by Science Service indicate that the majority of the winners in the National Science Fairs and the Westinghouse Science Talent Search developed their interest in science by the time they entered the sixth grade; and also because of the conclusion reached individually by several agencies (to say nothing of observations by parents) that lifetime reading habits are formed in early childhood.

Expanded Nuclear Training

THE International School of Nuclear Science and Engineering at the U. S. Atomic Energy Commission's Argonne National Laboratory will expand its activities and broaden its program to help meet new scientific needs of nations throughout the world.

It will then be known as the "International Institute of Nuclear Science and Engineering." The change will become effective in February, 1960, following completion of the Ninth Session of the International School in December, 1959.

The Institute will give greater emphasis to advanced training and will offer less background instruction, inasmuch as this type of training now is becoming available in colleges and universities. Personnel enrolled in the Institute will represent the United States and many foreign countries.

The International School was established in 1955 as one of the major projects of President Eisenhower's program for assisting friendly nations to develop peaceful uses of atomic energy. The School's classrooms and laboratories are located at the Argonne site 25 miles southwest of Chicago's Loop, near Lemont, Ill. The Argonne National Laboratory is operated for the Commission by the University of Chicago.

On-the-Job Study

HUMBLE Oil & Refining Company's 1959–1960 Lectures in Science and Engineering will include eight graduate level courses. Sixty-three U. S. scientists and five from foreign countries, each eminent in his field, have taught in this program since its initiation in 1946; 86 courses have been presented.

Each of the two-week courses represented about a semester of study and was attended by from 12 to 16 staff members. This has afforded each member of Humble's technical staff at Baytown the opportunity of having had an average of one course every two years. The participants were relieved of all other duties for the duration of the course.

Prof. W. H. R. Shaw of the Chemistry Department at The University of Texas will teach Advanced General Chemistry in January, and Prof. Cheves Walling of Columbia University's Chemistry Department will be in Baytown the last of February to present a course in Free Radicals in Solution. Theory of Thin Plates and Shells will be taught in March by Dr. Miklos Hetényi, Mem. ASME, professor of theoretical and applied mechanics at Northwestern University.

Fellowships

Fluid Mechanics. A BORIS A. BAKHMETEFF Research Fellowship will be available for the 1960–1961 academic year in an amount up to $3000. It is intended to be a specific contribution for a definite research project of an original and creative nature in the general field of mechanics of fluids.

The recipient shall be a full-time graduate student who is a candidate for the master's or doctoral degree. He shall not hold, or expect to hold, any other fellowship or major income-producing commitment that will interfere with his research work and study on a full-time basis. It is expected that the stipend will be adequate to cover tuition, subsistence, and, if necessary, a portion of the research expenses.

The study and research may be undertaken at an institution of the Fellow's choice. In the judgment of the Committee, the adequacy of the facilities of

the institution will have substantial weight in the selection of the Fellow.

Applications should be filed by February 15, 1960, with: Dean William Allan, School of Technology, The City College of New York, New York 31, N. Y.

AEC. The Atomic Energy Commission is accepting applications for 237 AEC fellowships for the 1960–1961 academic year in three programs which offer graduate training in specialized fields relating to nuclear energy. The fellowships are in the fields of nuclear science and engineering, health physics, and industrial hygiene. All are for U. S. citizens.

The programs are administered for the Commission by the Oak Ridge Institute of Nuclear Studies (ORINS), an educational corporation of 37 southern universities and colleges with headquarters at Oak Ridge, Tenn.

In the nuclear science and engineering program, 150 fellowships are available for first, intermediate, and final years of graduate school. The prerequisite is a bachelor's degree in engineering or physical science, and mathematics through differential equations.

The fellowships are for 12 months of study at 49 participating universities. The basic stipend is $1800 for the first year, $2000 for the intermediate year, and $2200 for the final year, with additional allowances for dependents.

The fellowships are awarded on a one-year basis, but renewals are available. The deadline for filing applications is Jan. 1, 1960.

Applications and further information on all three programs may be obtained from the Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

Educational Reactor

Work has begun on a $70,000 building at College Park, Md., to house the University of Maryland's 10 kw "swimming pool" nuclear reactor. This will be the first critical nuclear reactor in the State of Maryland.

The nuclear reactor, purchased from Allis-Chalmers Corporation, will provide facilities for training graduate and undergraduate students in the applied nuclear field.

The new building, to be located adjacent to the university's Chemical Engineering Building, will also house a nuclear reactor simulator purchased from Minneapolis-Honeywell Regulator Company and now operating, as well as an existing subcritical nuclear reactor which contains about three tons of natural uranium and uses two plutonium beryllium neutron sources all on loan from the AEC.

Students will obtain operating experience on the simulator and the subcritical reactor prior to work on the critical facility.

Grants from the Atomic Energy Commission, which to date have totaled $183,785, and funds from the State of Maryland have been used to purchase the reactor and related equipment.

MEETINGS OF OTHER SOCIETIES

Dec. 17

Institute of the Aeronautical Sciences, Wright Brothers Lecture, Smithsonian Institute, Washington, D. C.

Dec. 26–31

AAAS, annual meeting, Morrison and La Salle Hotels, Chicago, Ill.

Jan. 11–13

AIEE, American Society for Quality Control IRE, and Electronic Industries Association, national symposium on reliability and quality control, Statler-Hilton Hotel, Washington, D. C.

(For ASME Coming Events see page 134)

82-Year-Old Prime Mover Acquired by Smithsonian

The Smithsonian Institution in Washington, D. C., is acquiring a portable steam engine and boiler believed to have the longest operating record of any such engine in America.

Built in 1877, moved from place to place over rough roads, and left out of doors in all kinds of weather for decades, this outfit was in active service for 72 years. Now rebuilt, the engine runs smoothly in spite of its 82 years. The boiler is no longer able to withstand pressure, but has been fitted with new doors, a new stack, and new woodwork for the wheels.

The outfit was made by Frick Company at its plant in Waynesboro, Pa., and was the second model of a long line of portable engines. It was assigned number 315, and still carries this designation on the steam chest of the engine.

The equipment was first sold for use driving sawmills at various locations in the woods. After 25 years of this type of service, the engine was rebuilt, and put in service at a woodworking plant. Steam from the horizontal boiler was used for heating the building in winter, operating a kiln for drying lumber, and bending pieces used in chairs and other furniture; at the same time the engine drove the machinery.

Recently, when the big powerhouse near the woodworking plant was submerged by flood waters, the Frick engine was put back on its load.

The engine has a bore of 7 in. and a stroke of 10 in.; it was originally rated at about ten horsepower. The boiler has the old-style cone-shaped "expansion" band at the waist, and was one of the first pieces of Frick equipment to carry the "ECLIPSE" trademark, which later became known the world over.

82-year-old steam engine and boiler has had 72 years of active service and now, after overhauling, still runs smoothly despite its age. Engine is on display at the Smithsonian Institution, Washington, D. C.

Engineering Index Scans World-Wide Engineering and Scientific Publications

THE critical needs of engineers and scientists for better access to the rapidly mounting volume of engineering and scientific publications are being studied by a Science Information Service under the leadership of the National Science Foundation. James R. Killian, Jr , says "the increasing dimensions of world scientific publication has grown to the extent that it has become a problem requiring action at the national level." He said, "science and engineering are largely built on the published record of earlier work done throughout the world. There are, for example, 55,000 journals appearing annually, containing about 1,200,000 articles of significance for some branch of research and engineering in the physical and life sciences. More than 60,000 different books are published annually in these fields, and approxi mately 100,000 research reports remain outside the normal channels of publication and cataloging. Within this vast body of world-wide scientific information, published and unpublished, lie the technical data that scientists and engineers need to do their work. The situation is further complicated by the fact that a large and important proportion of the world's scientific literature appears in languages unknown to the majority of American scientists and engineers—such as Russian and Japanese."

World-Wide Coverage. Engineering Literature like missiles is directed on a world-wide basis. Furthermore, the volume is such that, unlike conditions at the beginning of this century, every engineer needs an international index service to keep abreast of the times. A good illustration proves the point: The American Society of Mechanical Engineers in 1911 held an annual meeting with a total of 14 papers—the same Society in 1958 at its Annual Meeting had 392 papers written by 656 authors. (Some papers today are presented in a symposium or prepared by two or more authors.) Of the 392 papers, 298 were preprinted: 165 will be published in full and digests of these, plus the remaining 133, were published in the "ASME Technical Digest" section of MECHANICAL ENGINEERING. ASME numbered papers (preprints) are available from the ASME Order Department for a limited period only. However, a complete set of the preprinted papers are deposited in the Engineering Societies Library and are indexed by the Engineering Index, both at 29 West 39th Street, New York 18, N. Y. Thus both published papers and papers which appear in pamphlet form only are made available through the Index to everyone.

Engineering Index. Indexing of papers in the Library is handled by The Engineering Index, a nonprofit organization. Since 1885 The Engineering Index has provided the most comprehensive indexing and abstracting service available to engineers and other specialists who must keep informed of technological developments all over the world.

Engineering Index employs a staff of qualified editors who review more than 1500 periodicals and society transactions, as well as a large number of bulletins and reports of government bureaus, schools, institutes, and research organizations. Publications in all branches of engineering and in all languages are reviewed. Articles which concern the application of engineering methods and concepts to any phase of the economy—and which are authoritative, informative, and useful—are abstracted.

The abstracts are easy to use. For each article reviewed, the following information is printed on a 3 × 5 library card: (*a*) Subject heading classification, (*b*) title of article and name of author, (*c*) name and date of publication, (*d*) brief summary of the article. Subscribers to individual divisions receive all pertinent abstracts once a week. Subscribers to the complete service receive their abstracts daily—about 30,000 a year.

All publications reviewed are permanently filed in the Engineering Societies Library. The Library—which is open to the public—supplies, at minimum cost, photoprints, microfilm, and translations of the complete text of any article abstracted by The Engineering Index.

Fields: 249. The Engineering Index covers all of engineering; its service is divided into 249 "Flieds of Interest." The subscriber who wants information in certain areas only may take only the divisions he needs. The Field of Interest classification is for the convenience of subscribers in ordering particular divisions. For filing purposes, however, the literature is classified according to a standard list of subject headings. This makes it relatively simple to incorporate the abstracts into most reference files. The complete list of subject headings is supplied free to "Complete Service" subscribers and may be purchased by others—both subscribers and nonsubscribers.

Subscribers use the Engineering Index in the following way:

Libraries. The Engineering Index offers libraries—both public and private—a ready made index to much of the world's technological literature. In libraries with extensive collections of technical journals, the Index is a valuable key. Where there is no technical collection, or only a small one, the Index enables the library to serve many more users than it could otherwise. At the same time—by generating requests for publications—it may indicate to the librarian where to begin acquisitions.

Industrial Firms. The major use of the Index is in industry where the pace of technological development demands a rapid, sure means of keeping informed. Here, in addition to its use in company libraries, are some of the functions Engineering Index performs for industrial subscribers.

General employee education—One large firm subscribes to the complete service, reprints and distributes the cards to technical personnel, according to job interest. Other companies reprint the abstract information in their own abstract bulletins.

Research and Development—Here, where knowledge of technical developments can be critical, Engineering Index enables engineers to keep current without reading hundreds of publications.

Public Relations—Service organizations frequently subscribed to the Index to keep informed and to be able to answer consumer inquiries in their field.

Trade Associations. A subscription to one or several Engineering Index Divisions is an inexpensive way for a trade or industry organization to keep alert to developments which it can pass on to member companies. Some subscribers in this category also use the Index to keep a check on publicity received by members.

Government Bureaus. Many federal, state, and local government agencies are among Engineering Index subscribers. Included are military departments, experimental stations, departments of sanitation, highways, air-pollution control, and water resources.

Schools and Universities. Not only school libraries, but also individual departments and faculty members subscribe to the Index for their own purposes.

Individuals. Many engineers and technological specialists personally subscribe to the Index simply to keep informed, or for reference and bibliographical help on specific projects.

The cost of The Engineering Index is economical and varies according to the volume of abstracts prepared from the

special field in which the subscriber is interested. The literature abstracted originates in 44 countries, and is published in 22 languages other than English.

The Engineering Index Catalog simplifies the search for required particular information from the mass of engineering information published in current technical engineering literature, no matter where it is printed. It is furnished in such brief and concise form that it conserves the searcher's time, energy, and expense, and keeps him fully informed of what is worth while and pertinent in his field.

The Engineering Index Service cards subsequently appear as a bound volume cumulating all of the references of the year. This volume, now in its seventy-fifth year, is an internationally accepted digest of technological literature prepared for engineers, research workers, and students. The Engineering Index has always been industry's authentic guide to the periodical technical literature. Today it still stands unrivaled. Engineers consider it a vital part of their reference equipment.

The progressive engineer knows that he must interest himself in all branches of technical research. He knows that the time has passed when he could limit his thinking to the field of engineering in which his immediate interests are involved. He realizes that he must be familiar with current developments in all phases of engineering and must inform himself concerning social and economic trends in order to assist in the solution of the major problems confronting humanity today.

The growth in enrollment of engineering students requires continuing effort to keep the influx of engineers into the profession fully informed as to all that is being done throughout the world in the development of the various phases of engineering. An effort should be made to persuade all Engineering Colleges and Schools, and perhaps all the secondary schools training technologists, to provide in the curriculm the important subject of "how and where" to find information covering the new literature reporting all kinds of progress and development in the various branches of Engineering and Technology.

West Coast Applied Mechanics Conference Initiates General Lectures

DURING the annual West Coast Conference of Applied Mechanics at Stanford University, Sept. 9–11, 1959 (MECHANICAL ENGINEERING, November, 1959, p. 130) a new feature was introduced in the program. Three General Lectures were delivered by outstanding specialists, who summarized the present status and recent developments in an area of applied mechanics in which they are particularly interested and active. Prof. R. M. Rosenberg, of the University of California, Berkeley, lectured on principal modes of vibration in nonlinear systems of more than one degree of freedom. Prof. E. Sternberg, Assoc. Mem. ASME, of Brown University, addressed the conference on stress functions in dynamic elasticity. The third general lecture on plastic analysis of plates and shells was delivered by Prof. P. G. Hodge, Jr., Mem. ASME, of Illinois Institute of Technology.

The lectures were enthusiastically received by the participating scientists, and were considered valuable contributions in stimulating interest and help in the initiation of further research in the areas of the subjects covered. The West Coast Committee has unanimously decided to make them a permanent feature in their annual Conference on Applied Mechanics. To Prof. K. Klotter, Mem. ASME, of Stanford University, goes the main credit for the initiation of these lectures.

The 1959 West Coast Applied Mechanics Conference was the most successful yet, and the trend toward a larger attendance that has been characteristic of the conference for several years now has continued. Approximately 150 scientists attended the conference.

As in previous years, the conference was sponsored jointly by the Applied Mechanics Division of The American Society of Mechanical Engineers and the American Society of Civil Engineers.

On the second evening of the meeting a large number of the participants were dinner guests of IBM at the new Research Laboratory of the Company in San Jose.

Coffee break or not—the discussion goes on. Left to right, Prof. R. M. Rosenberg makes a point as Dr. M. V. Barton, chairman, West Coast Committee, Applied Mechanics Division, ASME; Prof. W. Prager, secretary, Executive Committee, ASME Applied Mechanics Division; Prof. E. Pestel, Technical University, Hannover, Germany; and Prof. K. Klotter wait their turn.

Early engraving shows Cooper Union around 1860. The building has since been modified by the addition of more floors.

100

Unfinished portrait of Peter Cooper, inventor and philanthropist, who founded Cooper Union in 1859.

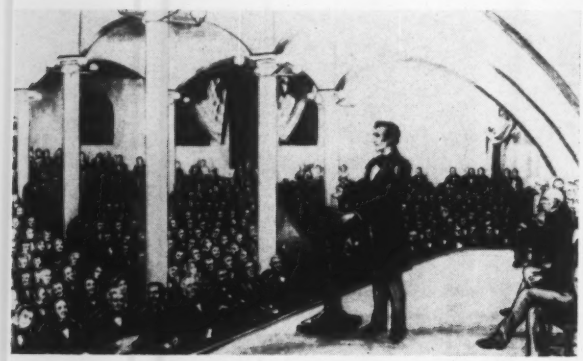
A dream worthy of the dreamer. The Cooper Union—a free school to "improve and elevate the working classes of the City of New York" housed in one of the oldest fireproof structures in the city—is a dream built by Peter Cooper of cast-iron beams.

In 1953, a hundred years after the dream had materialized, to commemorate the event, the American Institute of Steel Construction placed a tablet on the Cooper Union Building calling it the forerunner of the modern skyscraper. Such recognition was not based upon the building's height, but upon the great wrought-iron beams Cooper had fabricated for its construction. For it was those girders which provided the means to build future tall structures, cheaply, safely, and speedily.

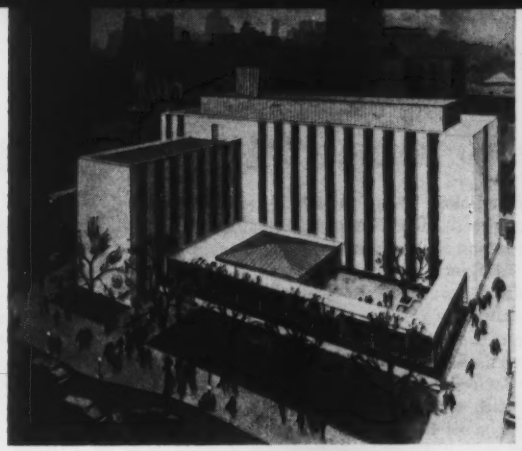
This year Cooper Union celebrates 100 years of service to its community. The school operates a tuition-free college in engineering and art; a library that was New York's first free reading room; a museum for the decorative arts; and an adult education program consisting of courses, lectures, and concerts free to the public since the day it was opened.

Its facilities now include a second building, the Hewitt Memorial Building. A third building, presently under construction, will be used exclusively by the School of Engineering. To finance construction of this new building, Cooper Union inaugurated a Centennial Development Program. Initial contributions of more than $1,250,000 have been made by some 3500 Cooper Union alumni. Gifts from public-spirited individuals, corporations, and foundations have raised the total to over $5,670,000 as of July 1, 1959. The Centennial goal is $7,500,000.

The Cooper Union has changed with changing times; yet, all of Cooper Union's offerings continue to be free of tuition or admission charge. Thus Cooper Union enters its second century with the promise of providing for American youth, in the terms of their own changing world, what Peter Cooper sought to provide for the rising generation of one hundred years ago.



Contemporary print shows Lincoln speaking in Cooper Union's Great Hall, Feb. 27, 1860



Architect's rendering of new building now under construction for Cooper Union's School of Engineering. Due to be completed late in 1960.

When The Cooper Union of today is compared with The Cooper Union at the start of its first academic year in 1859, the contrast is spectacular. Its faculty numbers 160 today as against 20. Today, its entire income of about $1,750,000 a year is devoted to free education. Its first budget was about $35,000.

YEARS OF THE COOPER UNION

In Electronics Laboratory students perform a basic experiment in wave-guide discontinuities

Mechanical engineering students study air-dynamics principles using a modern wind tunnel

Engineering School students and professor in machine design class

THE UNITED ENGINEERING CENTER

What ASME Is Doing. IN FOURTH place and still lagging: That summarizes ASME's position in the race among the five Founder Engineering Societies to achieve sufficient funds for the United Engineering Center.

Topped by the AIChE who exceeded their quota some months ago, the list of Founder Societies shows AIEE in second spot with 88 per cent of their quota achieved as of October 30, and a rapidly climbing ASCE in third place with 80 per cent already achieved. ASME stands at 72 per cent of quota with average weekly totals equaling less than one half of one per cent of our total quota.

Some bright spots are the 15 ASME Sections that have exceeded their quotas. Leading the list are Waterbury, Conn., with 182 per cent, and Cincinnati, Ohio, with 154 per cent.

Region V (Ohio, West Virginia, Pennsylvania area) leads the Regional list with 86.4 per cent of quota in, while Region II (New York Vicinity) is a close second with 85.5 per cent.

Why We're Doing It. The 140 staff members who conduct ASME's two-million-dollar-a-year operation are crowded into far too little space, often half the recommended amount. Active files are crammed into every available corner, often atop one another. Closeness of desks and lack of privacy lead to inefficiency. Inadequate light, heat, and ventilation are commonplace.

The new UEC, carefully planned to accommodate present operations as well as those of the foreseeable future, will eliminate these drags on efficiency.

How're We Doing? The record to date: All Sections are listed in order of per cent of quota achieved.

The following Sections have surpassed their quota: Waterbury, Cincinnati, C A M, Dayton, West Virginia, Worcester, Hudson-Mohawk, Atlanta, Hawaii, N. W. Florida, Youngstown, Columbia Basin, Olean, Westmoreland, Fort Wayne.

The following Sections have reached 50 per cent or more of their quota: Providence, Central Indiana, Metropolitan, Rock River Valley, Southern Tier, Birmingham, Anthracite-Lehigh, Central Michigan, Rochester, Pittsburgh, Iowa-Illinois, Delaware, Fairfield County, North Alabama-Mississippi, Sabine, Cleveland, Minnesota, Kansas City, Milwaukee, Detroit, Central Iowa, Mid-Hudson, Nebraska, Susquehanna, Columbus, Syracuse, Erie, Akron, Chicago, Baltimore, San Diego, Central Illinois, Western Washington, Central Savannah River Area, Arizona, Boston.

The following Sections have reached 25 per cent or more of their quota: West Massachusetts, Mid-Jersey, Philadelphia, Toledo, New Haven, Piedmont-Carolina, East Tennessee, Inland Empire, Central Kansas, New London, New Mexico, Utah, San Francisco, Eastern Virginia, St. Louis, Mexico, Ontario, South Texas, Mohawk Valley, Buffalo, Mid-Continent, Rocky Mountain, Hartford, Savannah, Oregon, Greenville.

The following Sections have reached less than 25 per cent of their quota: Los Angeles, Louisville, Central Pennsylvania, Florida, Washington, D. C., New Orleans, Eastern North Carolina, Virginia, North Texas, Northern New England, Central Virginia, St. Joseph Valley, Chattanooga, Miami.

Then It Hit Me

512 Moorman Avenue,
Colonial Heights, Va.,
October 7, 1959

Dear Sir:

I've been wondering why ASME officials are in such a sweat to get donations from ASME members for the new Engineering Societies Building in New York City. When the campaign first began I made a very small contribution just to get the solicitors off my neck. Now that they're ringing doorbells again, I can tell them, "I've paid mine; go hit somebody else!"

But the other day I asked myself just why I remain a member of an organization that asks me to give of my hard-earned money for a building which costs a fortune and which I may never set foot in. The only answers I could thing of were that I like taking advantage of some of the services furnished by ASME, and maybe someday I might get some sort of recognition as an ASME member.

Then it hit me. The Engineering Societies Building is the center from which those ASME services emanate. And those services certainly cannot be maintained if the engineering societies continue to grow while the Engineering Societies Building remains the same. As for the abstract idea of the recognition accorded individual engineers, I think it is largely governed by the recognition accorded the engineering profession as a whole. I have little doubt that a large, efficient, handsome Engineering Societies Building would enhance the prestige of the engineering profession, while the continued deterioration of the present building can only do the opposite.

I therefore find myself in the following paradox: If I am able to contribute my share, but I refuse, then I am refusing to support the very things that persuaded me to become an ASME member in the first place. Furthermore, I am told that ASME has a quota to meet, and that should they fail to meet it because of what I hold back, the difference would have to be made up from other ASME funds, the result being a reduction in the services and the prestige of ASME. Therefore in order to avoid being hypocritical of my own principles, I am voluntarily imposing on myself a tax-deductible dues increase for each of three years to cover a larger share of the cost of the new building.

My check made out to United Engineering Trustees, Inc., is enclosed herewith in partial payment.

Very truly yours,

W. J. Salot, Assoc. Mem. ASME[1]

[1] This letter reproduced with permission of the writer.

A coat closet doubles as washroom and houses duplicating equipment as well

Files are crammed into every available corner, leaving little working space

UET 1958–1959 Report Highlights Progress on United Engineering Center

THE United Engineering Trustees, Inc., recently released its annual report of the fifty-fifth year, 1958-1959, of its operation. The report was issued by UET President Andrew Fletcher to the Board of Trustees and the Founder Societies. The following excerpts are from his report:

General

UET assets totaling some $10 million (market value) are exclusively devoted to a multipronged operation for the "advancement of America's engineering leadership."

The area of new scientific and engineering frontiers of knowledge is spanned by the philanthropy of The Engineering Foundation.

Engineering knowledge becomes freely available through Engineering Societies Library, one of the finest engineering libraries in the world.

Recognition is awarded for outstanding achievement through the John Fritz Medal Award and the Daniel Guggenheim Medal Award.

UET serves as custodians or trustees of funds for several important research bodies and a federation.

Real estate holdings permit the engineering societies to live and work together under one roof.

United Engineering Center

We are now well advanced in the design of the new United Engineering Center which will more adequately house the engineering societies located in the present building and permit participation by several other engineering societies. Through this new engineering building, we believe that the several societies living together under a common roof will form bonds of mutual interest and activity which cannot help but achieve unity in action.

Site. The UEC site includes 37,500 sq ft of the block front on the west side of United Nations Plaza between East 47th and East 48th Streets, extending west 150 ft on East 47th Street and 225 ft on East 48th Street.

The entire site has been cleared and exempted from New York City real estate taxes.

The New Building. During the year it was necessary to make some modification in the basic design of the building, increasing the size of the tower and reducing the number of floors, but still providing 263,000 sq ft gross and 180,000 sq ft net, with a tower of 16 stories superimposed on the basic two-story building. In addition to the five Founder Societies, 13 other groups plan to participate in the building. Space was allocated to the 18 participating bodies on 14 floors of the tower, making it possible to leave two floors unfinished in the tower, a first provision for expansion.

The entire site will be utilized by a basement and two stories in which will be located meeting rooms, conference rooms, the Engineering Societies Library, Engineering Index, space for exhibition purposes, and a cafeteria, in addition to storage space and equipment rooms.

In May, 1959, Turner Construction Company was selected as general contractor. The architects and engineers completed working drawings on September 2, and the selected subcontractors submitted their bids by the end of the UET fiscal year. At the close of the year, the bids were being analyzed to determine the extent of any changes or revisions necessary to bring the work within the guaranteed limit of cost. Upon completion of this analysis and study, the construction cost of the Center will be finalized. The general schedule calls for occupancy in late 1961.

On Oct. 1, 1959, ground was broken in an impressive ceremony in which the Honorable Herbert Hoover participated. (MECHANICAL ENGINEERING, November, 1959, p. 106.)

Fund Raising

The expected cost of the project is $12 million, of which $2,750,000 is required for the site, an estimated $8 million for the building, and the remainder for necessary additional expenses for equipment, administration, legal, accounting, and contingencies.

The funds are being raised by gifts from Industry, from the members of the Societies, from the sale of the present building, and from the Depreciation Fund.

Industry Gifts Campaign. On Oct. 2, 1959, the total amount subscribed in the Industry Campaign, including a special campaign of Greater New York business, was $4,636,000 from 507 of America's leading corporations, the campaign goal is $5 million.

Mervin J. Kelley, Chairman of the Industry Fund Campaign, has initiated a termination program in the hope that the goal may be reached during 1960.

Member Gifts Campaign. Eleven national bodies made up of individual members are to occupy the building. These societies have accepted individual fund raising quotas, the total of which is $3,780,000. As of Oct. 2, 1959, $2,667,811 has been secured in subscriptions, leaving an unattained quota of over $1,100,000.

Vigorous efforts are being carried on by all of the societies to attain their quotas early in 1960.

Occupancy of UEC. In addition to the five Founder Societies, prospective Associate Societies which have expressed an interest in participating in the new United Engineering Center are: American Institute of Consulting Engineers, American Institute of Industrial Engineers, The American Society of Heating, Refrigerating and Air-Conditioning Engineers, American Welding Society, Illuminating Engineering Society, and Society of Women Engineers; in addition, several joint bodies will be included.

The responsibility for management, construction, and administration of the UEC will rest with the Board of Trustees. However, operation of the Center will be handled by an advisory committee with representation from both Founder and Associate Societies; one of the principal responsibilities of this committee will be to recommend to the Board of Trustees, from time to time, paper space assessment rates.

Similarly, the Associate Societies will have a voice in the management of Engineering Societies Library and will share in its financial support on a uniform basis.

The Founder and Associate Societies, together with their several joint agencies, will make the new UEC the focal point of American engineering.

ASME members of the Board of the United Engineering Trustees are: H. E. Martin, W. F. Thompson, and F. S. Blackall, Jr.

Engineering Societies Library

Recognizing that the strength of our technology depends to a large extent upon the organization and availability of the world's engineering literature, the Engineering Societies Library, as the educational arm of UET, endeavors to provide engineers with a type of service unmatched elsewhere in the world. Evidence of the usefulness of the Library is demonstrated by a 23 per cent increase in the use of the Library in the past two years. The Library translation service covers the various languages of the world.

The Library Board has already initiated specific planning which will permit the development of an even more useful

Library in the proposed new UEC. With the expansion of facilities, the Library will be able to extend still further the quantity and the quality of its services to all engineers and to industry.

Representing ASME on the Engineering Societies Library Board are: W. L. Betts and F. M. Gilbreth.

Engineering Foundation

The Engineering Foundation, as the research arm of UET, endeavors to advance the frontiers of man's engineering knowledge.

The Engineering Foundation is currently developing a new policy which will tend to more greatly utilize the highly skilled talent in our Engineering Societies' membership to define voids in our knowledge and establish needed research in such areas.

E. L. Robinson and R. C. Allen represent ASME on the Engineering Foundation Board.

Medal Awards

UET, also is custodian of two medal awards: The John Fritz Medal Award "for scientific or industrial achievement in any field of pure or applied science," and the Daniel Guggenheim Medal Award for "notable achievements in the advancement of aeronautics."

The 1960 recipient of the John Fritz Medal is Gwilym A. Price, affiliate ASME, for his inspirational leadership, industrial pioneering, and personal initiative in marshaling the creative forces of research and engineering to the cause of developing atomic power for the national defense and for the human welfare.

The 1959 recipient of the Daniel Guggenheim Medal is Sir George Edwards for a lifetime devoted to the design of military and commercial aircraft culminating in the successful introduction into world-wide commercial service of the first turbine powered propeller driven aircraft.

Other UET Activities

UET serves as fiscal agent for the following organizations: Alloys of Iron Research, Column Research Council, Corrosion Research Council, Engineers' Council for Professional Development, Reinforced Concrete Research Council, Research Council on Riveted and Bolted Structural Joints, Thermal Resistivity Characteristics of Soils, and Welding Research Council.

UET retains legal counsel, investment advisers, auditors, financial counsel, real estate advisers, consulting architects, insurance advisers, and a consulting actuary in order to insure receipt of the finest possible advice in its diverse operations.

Finances

As of the end of the fiscal year 1958–1959, UET's Balance Sheet Assets totaled some $8.9 million, an increase of about $2.2 million over the previous fiscal year.

The total real estate assets of UET are listed as $6.37 million. There are no mortgages or notes outstanding.

Professional Advisers

Advisers are retained by the Board of Trustees on all phases of its work in order to obtain the best information available.

They include: Financial Counsel, W. Barton Cummings, Vice-President, Chemical Bank New York Trust Company; Investment Adviser, Wood, Struthers & Company, M. S. Harrison, Partner; Legal Counsel, Simon Presant; Consulting Architects, Shreve, Lamb & Harmon Associates; Consulting Actuary, George B. Buck; Insurance Advisers, Frank & DuBois; and Auditors, Haskins & Sells, CPA.

LITERATURE

ASME Publications

The American Society of Mechanical Engineers issues annually a large number of publications. Many of these are the products of efforts of the Society's Boards and Committees working independently or in conjunction with other societies. Often these publications are available at a 20 per cent discount to ASME members.

A list of the most recent of these publications obtainable from the ASME Order Department, 29 West 39th Street, New York 18, N. Y., follows:

- **"Spray Literature Abstracts,"** by K. J. DeJuhasz, $12, published with the support of the National Science Foundation. Abstracts of over 1300 literature items dealing with scientific, technical, and industrial sprays.
- **"Fluid Meters—Their Theory and Applications,"** Fifth Edition, $8, report of ASME Research Committee on Fluid Meters.
- **"Nuclear Reactor Plant Data,"** two volumes: Power Reactors, $3.75, and Research and Test Reactors, $7.50.
- **"Structural Damping,"** edited by J. E. Ruzicka, $4.25, papers presented at a colloquium on structural damping at the ASME Annual Meeting in December, 1959, sponsored by the Shock Vibration Committee of the Applied Mechanics Division.
- **"Drill Drivers,"** ASA B5.27–1959, $1, sponsored also by ASTE, Metal Cutting Tool Institute, National Machine Tool Builders Association, and SAE.
- **"Oil Transportation Piping,"** ASA B31.4–1959, $2.50.
- **"Material Specifications,"** 1959, Section II, ASME Boiler and Pressure Vessel Committee on Materials.
- **"Unfired Pressure Vessels,"** 1959, Section VIII, ASME Boiler and Pressure Vessel Code, $6, report of Subcommittee of Boiler and Pressure Vessel Committee.
- **"Welding Qualifications,"** 1959, Section IX, ASME Boiler and Pressure Vessel Code, $2.25, formulated by the Boiler and Pressure Vessel Committee.

Hydraulic Research

"Hydraulic Research in the United States, 1959" edited by Helen K. Middleton, is the latest in a series of annual publications which report on hydraulic research conducted within the past year in the U. S. and Canada. The publication serves as a guide in the co-ordination and planning of hydraulic research, and is a contribution to a broad effort to avoid duplication of research in the field.

Listed as National Bureau of Standards Miscellaneous Publication 227, the 188-page report costs $1.25. Order from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Bibliographic Listings

Oscillations. A bibliography on combustion-driven oscillations has been compiled by specialists at Battelle Memorial Institute. Edited by Abbott Putnam and Carl Speich, it includes more than 550 references to literature on pulsations and noise associated with combustion which may be of value to designers and builders of combustion equipment for residential, industrial, and military use.

- **AEC.** "Technical Books," a catalog of 86 books published by the U. S. Atomic Energy Commission since 1947, also lists 26 volumes in press or in preparation. Copies of the 40-page book list may be obtained from the AEC Technical Infor-

mation Service Extension, Oak Ridge, Tenn.

A cumulative list of all AEC Research Reports, Price List No. 32, may be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

• **Welding.** The American Welding Society has announced the availability of the 1958 Supplement to the AWS Bibliographies. The original publication contained bibliographies of articles which appeared in the *Welding Journal* from 1937 through 1957. The Supplement contains listings of all articles appearing in the *Welding Journal* in 1958. The complete Bibliographies thus provide a record of all articles on welding, welding research, and related subjects which have appeared in the magazine from 1937 through 1958. Copies of the 1958 Supplement to the AWS Bibliographies may be obtained at $1.50 from the American Welding Society, Department T., 33 West 39th Street, New York 18, N. Y.

• **Design Engineering.** "The Engineer's Bookshelf," by Richard M. Koff, senior associate editor, McGraw-Hill Publishing Company, is a detailed bibliography of technical books for the design engineer. Basis for selection of books in the list was that they be terse, informative, comprehensive without excessive detail, practical rather than theoretical in approach, and well indexed. Copies are 25 cents, and may be obtained from Readers Service Department, *Product Engineering*, 330 West 42nd Street, New York 36, N. Y.

Heat Transfer and Fluid Mechanics

Preprints of papers presented at the "1959" Heat Transfer and Fluid Mechanics Institute" held at the University of California, Los Angeles, Calif., June 11–13, 1959, are available in a single paper-bound volume. Copies cost $7.50; and may be obtained from the Stanford University Press, Stanford, Calif.

Russian Translations

• The Instrument Society of America under a grant-in-aid from the National Science Foundation has undertaken the cover-to-cover translation of four Soviet journals. The journals are: *Measurement Techniques*, *Instruments and Experimental Techniques*, *Automation and Remote Control*, and *Industrial Laboratory*. For additional information write Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

• The National Science Foundation has recently published a detailed survey listing 76 Soviet journals now available in English. The report, "Providing U. S. Scientists with Soviet Scientific Information," also discusses the form and extent of Soviet information that should be made available in the U. S. and what is actually being done to make this material readily accessible. The report is available from the Office of Science Information Service, National Science Foundation, Washington 25, D. C.

Aeronautics

"Advances in Aeronautical Science," proceedings of the first International Congress of the Aeronautical Sciences, Madrid, Spain, 1958, is now available. The two-volume set contains 46 papers by the world's leading specialists in the field. Cost is $30, copies may be obtained from Pergamon Press, 122 East 55th Street, New York 22, N. Y.

Pergamon Press has also recently published the "AGARD Eight-Language Aeronautical Dictionary." AGARD is the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization. The dictionary is $20.

ASHRAE 1959 Guide

The "Heating, Ventilating, Air-Conditioning Guide 1959," 37th Edition, has recently been published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. The 768-page Technical Data Section of the Guide follows the general format of previous editions. Copies cost $12 and may be obtained from ASHRAE, 62 Worth Street, New York 13, N. Y.

Maintenance

"Techniques of Plant Maintenance & Engineering," is the tenth volume in an annual series published by Clapp & Poliak, Inc. The 266-page book covers a large number of practical situations, and contains all papers read at the 1959 Plant Maintenance & Engineering Conference held in Cleveland, Ohio, last January. The volume is $10. Write Clapp & Poliak, Inc., 341 Madison Avenue, New York 7, N. Y.

ASTM Standards

The "1958 Book of ASTM Standards," a 10-part work of The American Society for Testing Materials, is now available. Distributed throughout the world, ASTM standards are used to cover production, purchase, and evaluation of millions of dollars worth of material annually. Within the 10 parts are 2450 standard specifications, methods of test, definition of terms, and recommended practices. Each part contains a detailed subject index and numerical list of standards. The complete set is $116.

National Electrical Code

The new "1959 National Electric Code" is now available. The 528-page Code is a complete revision of the 1956 edition. Copies of the Code (NFPA No. 70, $1 a copy) may be ordered from the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.

NEMA Gas-Turbine Standards

"Gas Turbine Power Plants, SM 30-1959," represents the result of two years of work by top engineers from all domestic producers of this comparative newcomer to the prime mover field. Data covers horizontal gas-turbine power plants used for stationary mechanical drive or for power-generation land installation. Copies of the standard may be obtained for $1 from NEMA Headquarters, 155 East 44th Street, New York 17, N. Y.

TV and Film Data

A "TV and Film Production Data Book," by E. M. Pittaro contains over 198,000 words, 132 photographs and drawings, and 128 useful tables. Quick reference headings at the top of every page and convenient groupings in 25 main categories make the handbook easy to use. The book costs $6.95 and is published by Morgan & Morgan, Inc., Publishers, 101 Park Avenue, New York 17, N. Y.

PEOPLE

Honors and Awards. Kurt Berman, Assoc. Mem. ASME, manager of liquid-propellant engineering at the General Electric Company's Malta Test Station, has been named a fellow of the American Rocket Society and an adjunct professor of aeronautical engineering at Rensselaer Polytechnic Institute, Troy, N. Y

Augustus B. Kinzel, vice-president in charge of research, Union Carbide Corporation, was named recipient of the Industrial Research Institute Medal for 1960. The medal has been awarded annually since 1945 to honor "outstanding accomplishment in leadership in or management of industrial research which contributes broadly to the development of industry or the public welfare."

Max H. Foley, former partner in Voorhees, Walker, Foley & Smith, and Frederick C. Gardner, president, Ebasco Services, Inc., are the recipients

of the 1959 awards for distinguished service presented by the New York City Chapter of the New York State Society of Professional Engineers.

SOLOMON LEFSCHETZ, internationally known mathematician, has received an honorary doctorate from the University of Paris. Dr. Lefschetz has recently come out of retirement as professor-emeritus of Princeton University to direct the mathematical investigations at the Research Institute for Advanced Study, a Division of The Martin Company.

GENERAL DAVID SARNOFF, chairman of the board, Radio Corporation of America, is to be the first recipient of a medal struck in his honor. The medal will be awarded annually by the AIEE for an outstanding achievement in the field of electronics. Its inauguration was made possible by the co-operation of RCA.

W. L. BARTH, retired executive secretary, General Motors Corporation Standards Committee and head of its Standards Engineering Section, has been named the recipient of the ASA 1959 Standards Medal.

The standards society's Howard Coonley Medal was awarded to V. DEP. GOUBEAU, vice-president and director of materials, Radio Corporation of America.

HANS A. BETHE, theoretical physicist and professor at Cornell University, received The Franklin Medal, the highest award of the 135-year-old Franklin Institute.

Dr. Bethe is a consultant to the U. S. Atomic Energy Commission and a member of the President's Scientific Advisory Committee.

WESTINGHOUSE ELECTRIC CORPORATION is the first recipient of the Mamie Doud Eisenhower Award for contribution to nuclear propulsion. The award is a medal created by the New York Shipbuilding Corporation, Camden, N. J., to commemorate the launching by Mrs. Eisenhower of the *NS Savannah*. The Federal Maritime Board will present the medal annually to a person or organization making an outstanding contribution to nuclear propulsion.

New Officers. JOHN V. GRIMALDI, Mem. ASME, consultant in safety and plant production for the General Electric Company, has been installed as second vice-president of the American Society of Safety Engineers. The society, with headquarters in Chicago, is a professional organization of safety engineers dedicated to upholding the standards of their profession and using their abilities for human service in the nation, the state, and the community.

GEORGE W. MARTIN, Holyoke Plastics Company, Holyoke, Mass., will take office as the new president of the Society of Plastics Engineers on Jan. 11, 1960. Mr. Martin will be installed during the society's annual technical conference to be held at the Conrad Hilton Hotel, Chicago, Ill.

LIEUT. GEN. DONALD L. PUTT (USAF, ret.) has been elected president of The Institute of the Aeronautical Sciences for 1960. General Putt is president of United Research Corporation, a newly formed subsidiary of United Aircraft Corporation, Menlo Park, Calif.

New Appointments. RICHARD A. WOLFF, Mem. ASME, has been named Deptuy Commissioner of the New York City Department of Air Pollution Control. Commissioner Wolff has been a member of the New York City Board of Air Pollution Control since its inception in 1953.

EDWARD V. LEWIS has been appointed head of a five-nation committee which will correlate laboratory tests carried out in various countries on scale models of tankers and cargo ships. Professor Lewis is head of the Ship Division of The Davidson Laboratory at Stevens Institute of Technology.

Campus Data. WILLIAM R. OSGOOD, Mem. ASME, professor of mechanics and head of the department, Rensselaer Polytechnic Institute, is retiring June 30, 1960.

World's First Scale-Model Atomic Power Plant. The "Westinghouse Atomic Electric Power Plant"—world's first scale-model plastic hobby kit showing detailed construction of a typical atomic electric generating station—is being examined here by William E. Shoupp, **left**, Mem. ASME, technical director of the Westinghouse atomic power department, and George Gail, 12-year-old seventh grade student at the Jefferson Junior High School, Mt. Lebanon, Pa. The kit built by Revell, Inc., and being placed on the retail market this month for the first time, has complete interior and exterior details including the reactor, steam generator, pumps, turbine generator, transformers, circuit breakers, and transmission lines and tower. Dr. Shoupp is shown pointing to the top of the reactor inside its housing, the front section of which is removable. When assembled, as it is displayed here, the kit has a base 18 inches square.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

Quarterly Transactions Plan Completes First Year of Operation

PUBLICATION this month of the *Journals of Basic Engineering* and *Applied Mechanics* completes the first year of operation of Transactions of the ASME under the new quarterly series plan.

This plan, developed by the Publications Committee after years of study, was approved by the Board on Technology and the Executive Committee of the Council during 1958. The first quarterly under the new plan, the *Journal of Engineering for Power*, was issued in January, 1959. Others in the series include the *Journal of Engineering for Industry* and the *Journal of Heat Transfer*.

This development, one of the most important in ASME's continuing study and realignment of its periodical publications, has provided ASME members with a series of technical journals wherein the technical content has been categorized into more usable packages.

That the plan has thus far enjoyed moderate success can be indicated by subscriptions at this time. As of Nov. 2, 1959, subscriptions to the new quarterlies were as follows:

Journal of Engineering for Power	3816
Journal of Engineering for Industry	3442
Journal of Heat Transfer	3882
Journal of Basic Engineering	4853
Journal of Applied Mechanics	5588

Thus there are now 21,581 subscriptions to the new Journals. This compares to about 5000 for the eight issues of Transactions and 6000 for the *Journal of Applied Mechanics* under the old method of publication.

Indications are that the Journals are also continuing to serve as valuable reference works. Examples: *Power Reactor Technology*, a quarterly technical progress review prepared for the U. S. Atomic Energy Commission by General Nuclear Engineering Corporation, cited a paper and a graph from the May, 1959, issue of the *Journal of Heat Transfer;* a paper on the grid method in stress analysis which appeared in the *Journal of Applied Mechanics* was abstracted in *Engineering Materials and Design*, a British publication.

In conjunction with the new Transactions plan, a family of covers was designed for the new journals. In addition, the format of the editorial content was revamped, including the selection of new type faces for the titles and abstracts to permit easier and faster readability.

Price schedule for the quarterlies is as follows:

No. of Journals	Member Price	Nonmember Price
1	$5.00	$10.00
2	9.00	18.00
3	12.50	25.00
4	15.00	30.00
5	16.50	33.00

All ASME members were afforded an opportunity to subscribe to the new journals on the Annual Dues Statement which was mailed to the membership in August. However, for those who missed this opportunity, a convenient order coupon will be found on this page. So, to keep abreast of the important technical literature in mechanical engineering, use this coupon now.

Order Form—ASME Transactions Quarterly Journals

Amer. Soc. Mech. Engrs.
29 W. 39th St., New York 18, N. Y.

Date_____

Enter my subscription to the ASME TRANSACTIONS Quarterlies "checked" below for one year.

- ☐ *Journal of Engineering for Power*
- ☐ *Journal of Engineering for Industry*
- ☐ *Journal of Heat Transfer*
- ☐ *Journal of Basic Engineering*
- ☐ *Journal of Applied Mechanics*

Annual Subscription Rates to ASME members:
$5 for any one; $9 for any two; $12.50 for any three; $15 for any four; $16.50 for any five.

Prices are double to nonmembers.
Add 50¢ to price of each journal if mailed outside of U. S. and Canada.

Name .....

Address .....

City ..... Zone ..... State .....

☐ Remittance enclosed ☐ Bill me

Check here if member ☐

"Let's start"... Oscar Pinkus, session vice-chairman, **left,** checks time with Chairman A. A. Raimondi

"OK"?... Sessions seems to be moving along without any difficulties

"Right on the nose." Papers and discussions presented in time allotted

"In the design of self-aligning journal bearings, misalignment torque is important," says J. S. Ausman

Space Age Changes Lubrication Picture
300 Hear at Sixth ASLE-ASME Conference in New York City

More than 300 registrants attended the sixth annual Lubrication Conference at the Hotel Sheraton-Atlantic in New York City on October 20–22, jointly sponsored by the American Society of Lubrication Engineers and The American Society of Mechanical Engineers.

They heard 26 papers in seven sessions covering the general subjects of fluid properties, hydrodynamic bearings, metal working, high-temperature lubrication, basic friction and wear theory, and rolling contact bearing mechanisms.

Space Age subjects, such as operation of gears in inert atmospheres and radiation resistance of new synthetic fluids, were complemented by advances in older areas such as new theories of metal cutting, a general equation for expressing the loadings and paths of balls and rollers in bearings, and rules for oil ring sleeve bearings.

A Social Hour, held October 20 from 5:30 to 7:30 p.m. and sponsored by six of the major oil companies, was well attended and proved to be popular. It provided an opportunity for those attending to relax and discuss work of mutual interest.

Technical Papers

A study of the early stages of oil oxidation at temperatures of 500 to 550 F was made in a specially designed closed system that insured highly oxidative conditions. Both the rate of oxygen volume taken up by the oil and the extent of deposits on a hot revolving disc were determined. Tests of base oils containing various antioxidants showed that their action persisted even at these high temperatures. A temperature coefficient of reaction of 2.0 per 18 F was found for the temperature range of 475 to 575 F.

Analytical investigation of viscoelastic effects in the lubrication of rolling contact showed that shear elasticity can have effects of first-order significance on both the magnitude and form of the pressure distribution function; reducing load-carrying capacity and maximum shear stress in the film by sizable amounts.

Meta-linked polyphenyl ethers, developed in anticipation of future turbojet requirements, have shown themselves in the laboratory to be liquids with superior oxidation, thermal and radiation stability, and to have considerable promise for service under extreme temperature and radiation conditions.

In the session dealing with hydrodynamic bearings the calculated performance of bearings lubricated with non-Newtonian polymer-thickened oils was discussed. A Sommerfeld solution for finite bearings with circumferential grooves was presented that circumvented the algebraic complexity in the solution of Reynolds differential equation.

Past studies have established many of the details of oil-ring behavior. A further analysis was directed particularly at obtaining quantitative expressions for ring speed and for oil delivery as a function of the oil characteristics, the geometry of the ring and journal, and the bearing operating conditions.

One paper on hydraulic gas bearings developed expressions for pressure profile, gas-flow rate, gap height and load-carrying capacity of pad and step bearings that yielded results in excellent agreement with experimental data. In another paper, perturbation analysis was used to develop expressions for determining the journal restoring torque resulting from misaligned gas-lubricated bearings—of particular interest in high angular stiffness bearings required for gyroscope rotors.

Various aspects of wear were discussed in five papers, three of which were concerned with the evaluation of materials for use at high temperatures. For gears at 700 F lubricated with oil, M1 high-speed tool steel was found to give the best score resistance, whereas H-12 (AISI) hot-worked die steel gave the best results with silicone.

With iron, copper, nickel, molybdenum, and chromium rubbing against themselves, high friction and considerable surface damage resulted until a particular transition temperature was reached. Above this temperature sliding characteristics improved and were associated with the generation of oxides in the sliding track.

In studying friction and wear of nickel alloys at 1000 F, it was found that additions of silicone have considerable beneficial effect. The role of silicone as a film

"To study bearing oil-ring performance a series of tests were made with rings of various sizes and at journal speeds..." says D. C. Lemmon

One good turn... H. A. Hartung discusses a technical paper and someone marks time on him. Earlier, as chairman of Properties of Lubricants Session, he kept time.

former was found to be more important than increased hardness.

Using a new technique that included radiotracer counting, autoradiographic analysis, densitometer and numerical integration, results were obtained that showed not only how much E.P. film was formed on wear surfaces by the additive, but it also pinpointed areas on the mating parts where the film concentrated.

In a study of seizure phenomenon in the Four Ball Wear Machine, it was found that the estimated surface temperature corresponding to the transition from no-seizure to seizure increases with decreasing ratio of load to speed.

Application of an inert-gas atmosphere to a lubrication system presents attractive possibilities as a means for extending the capabilities of available lubricants to higher temperatures. An investigation of the effect of nitrogen and argon atmospheres on gear lubrication disclosed that the load-carrying ability of mineral oils both with and without additives was improved whereas with synthetic lubricants this was not always the case.

Damping as a means of controlling the vibration of cantilever beams, such as turbine blading, has long been recognized. Investigation of the damping effect of lubrication at the roots of cantilever beams indicated that soft metal plating such as silver was effective but not as effective as grease.

A systematic study of wear between unlubricated tool steel and refractory metals bonded by powder metallurgy techniques with softer metals developed potential rotating-seal materials for high-speed and high-temperature conditions encountered in aircraft applications. Two ternary alloys, one nickel-bonded tungsten-boron, the other chromium-nitrogen infiltrated with silver, gave good results.

A method of using labyrinth-seal leak-rate data from tests on only two characteristic seals to calculate leak rates through an entire family of seals produced accuracies which, according to the author, are on the order of 3 per cent. This compared with 20 to 100 per cent errors obtained where purely theoretical calculations were made.

Dry grinding of steel with coated abrasives was found to be influenced by atmosphere in which the grinding takes place. The coefficient of friction between the Al_2O_3 grits and steel is decreased and grinding rate and abrasive life increased to a greater extent in atmospheres of Cl_2, H_2S, and HBr than in air.

Various lubricants and coatings were investigated as part of a process development program on cold extrusion of titanium. From the standpoint of producing the best surface finish at the lowest extrusion pressure, best results were obtained with a fluoride-phosphate chemical conversion coating on the unalloyed titanium and a lubricant of self-drying gum resin mixture containing ten per cent graphite or five per cent of both graphite and molybdenum disulphide.

The final session was devoted to four papers dealing with rolling-contact bearings. An investigation of ball thrust bearings disclosed that the spinning action of the ball with respect to the race should account for the major part of the over-all friction. The friction force varied considerably with type of lubricant.

The importance of retained austenite in the selection of instrument rolling-contact bearing materials was demonstrated. Material with no retained austenite has the least rolling friction, and the smaller the retained-austenite content, the higher the contact stress necessary to initiate macroplastic deformation.

The effect of hardness, surface finish, and grain size on the rolling-contact fatigue life of M50 bearing steel was investigated on the R C test Rig and a mathematical expression relating these variables to life expectancy was developed.

Iterative techniques, adaptable to high-speed digital computers, were developed and programmed for an IBM 704, in order to develop a completely general solution for determining the elastic compliances of any number of ball and radial roller bearings under any system of loads.

1960 Lub Conference

Next year's Conference, in which ASME will be the lead society, will be held in Boston, Mass., on Oct. 17–19, 1960. Papers are being solicited now, and authors wishing to offer a paper may inform Papers Co-Ordinator, R. L. Johnson, NASA Lewis Research Center, 21000 Brookpark Road, Cleveland 35, Ohio.

An availability list of papers presented at this meeting follows. Digests of all papers which are not scheduled for publication in MECHANICAL ENGINEERING will appear in the "ASME Technical Digest" in this or a forthcoming issue of MECHANICAL ENGINEERING.

Availability List— ASME-ASLE Lubrication Conference

THE papers in this list are available in separate copy form until Aug. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in books of ten, are $3 to members; $6 to nonmembers.

59—LUB-1 Hydrostatic Gas Bearings, by John H. Laub

59—LUB-2 The Effect of Ball Bearing Steel Structure on Rolling Friction and Contact Plastic Deformation, by R. C. Drutowski and E. B. Mikus

59—LUB-3 Torque Produced by Misalignment of Hydrodynamic Gas-Lubricated Journal Bearings, by J. S. Ausman

59—LUB-4 A Sommerfeld Solution for Finite Bearings with Circumferential Grooves, by J. V. Fedor

59—LUB-5 Bearing Oil-Ring Performance, by D. C. Lemmon and E. R. Booser

59—LUB-6 The Effects of Atmosphere on Dry-Grinding Steel with Al_2O_3 Coated Abrasives, by E. J. Duwell and W. J. McDonald

59—LUB-7 A General Method for Correlating Labyrinth-Seal Leak-Rate Data, by F. E. Heffner

59—LUB-8 The Oxidation of Lubricating Oils at High Temperatures, by A. L. Williams and E. A. Oberright

59—LUB-9 The Importance of Spinning Friction in Thrust-Carrying Ball Bearings, by G. S. Reichenbach

59—LUB-10 A General Theory for Elastically Constrained Ball and Radial Roller Bearings Under Arbitrary Load and Speed Conditions, by A. B. Jones

59—LUB-11 Effect of Hardness, Surface Finish, and Grain Size on Rolling-Contact Fatigue Life of M50 Bearing Steel, by R. A. Baughman

What does the future hold for the mechanization of coal mining and coal handling? ASME and AIME join in a technical session.

Guest speaker at the banquet: Utility President E. S. Fields

Ladies: If your husband was a member of either society, you were invited on the Ohio River cruise

First day, first technical session. **Left to right:** M. P. Corriveau, W. E. Butler, C. P. Blair, H. E. Mauck.

H. H. Lowry, **left,** scientist and distinguished writer on the chemistry of coal, receives the Percy Nicholls Award from D. R. Mitchell, chairman of the Award Committee

Long-Range Possibilities

At Cincinnati, in the heart of the Ohio Valley with its burgeoning industry, The American Society of Mechanical Engineers and the American Institute of Mining, Metallurgical, and Petroleum Engineers held their twenty-third Annual Solid Fuels Conference, Oct. 27–29, 1959. The conference, sponsored jointly by the ASME's Fuels Division and AIME's Coal Division, in co-operation with our Cincinnati Section and AIME's Ohio Valley Section, drew some 170 engineers to analyze the Valley's industrial development and to study the long-range possibilities of mechanized mining.

Headquarters of the conference was the Netherland Hilton Hotel in downtown Cincinnati.

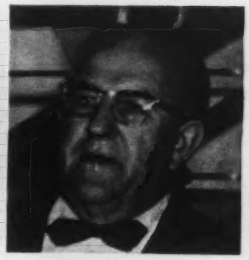
The Percy Nicholls Award

A feature of each Joint-Fuels Conference is the presentation of the Percy Nicholls Award, a joint honor of the ASME and AIME. It went, this year, to Homer H. Lowry, editor-secretary of the Committee on Chemistry of Coal, National Academy of Sciences—National Research Council, "In recognition of outstanding achievement in the field of solid fuels." A prolific writer, Dr. Lowry is the chief architect of the monumental two-volume book on "Chemistry of Coal Utilization," sponsored by the National Research Council.

Technical Papers

The 12 technical papers presented at Cincinnati served as points-of-departure for unusually rewarding discussions of the fields of solid-fuel mining and utilization. The trend toward shorter presentation of papers and longer and more diversified discussions is one which

A. A. Potter, past-president of ASME, speaks at the "business luncheon"



J. E. Tobey, Fellow of the ASME, at the banquet

of Mechanizing Mining

the ASME hopes to see in all its conferences. An availability list of papers presented at this meeting appears at the end of this article. Digests of all papers which are not scheduled for publication in MECHANICAL ENGINEERING will appear in the "ASME Technical Digest" in this or a forthcoming issue of MECHANICAL ENGINEERING.

Inventiveness and Human Betterment

On its first day, Wednesday, Oct. 28, the Conference held a "Business Luncheon," presided over by W. C. Bismeyer, Chairman of ASME's Cincinnati Section. Speaker at this luncheon was Andrey A. Potter, president of Bituminous Coal Research, Pittsburgh, Pa., and the 52nd President of ASME (1932–1933). Dr. Potter spoke on "Inventiveness and Human Betterment."

"Throughout history," Dr. Potter said, "people have satisfied their material wants either by depriving others through robbery, trickery, enslavement, and offensive warfare, by exploration and colonization, or by creating new wealth through hard work, discovery, innovation, and inventiveness. Americans, more than any other people, have . . . satisfied their wants through hard work and inventiveness . . . . Our entire social structure has been altered by inventors who are the constructive builders of our civilization."

The Elite—Technical or Moral?

Dr. Potter believes that we can step up our tempo of creativeness, and that inventors can be trained and stimulated. He offered the opinion that radio, television, and the movies have a great opportunity to foster creative hobbies and to stimulate inventiveness. He thinks that our universities need more teachers who are themselves innovators as well as scholars. This last is especially important, because it appears that the more schooling people have, the less

Studied at ASME-AIME

interest they develop in becoming innovators and in "plowing new furrows in human progress." On the other hand, he joins Dr. Walter E. Boveri, president of Brown Boveri, in his concern that technical devices, instead of benefiting humanity, may lead to the destruction of some of man's most precious qualities (MECHANICAL ENGINEERING, July, 1959, pp. 34–37).

Dr. Potter quoted Le Chatelier who—more than 50 years ago—concluded that an intellectual elite is not more important than a moral elite who respect the rights of others and fully appreciate the meaning of liberty.

"This world needs more creative leaders in all fields," Dr. Potter said, "but even more so, people of character who feel most and act noblest toward their fellow human beings."

The Ohio Story

J. E. Tobey, who is a Fellow of ASME besides serving as General Conference Chairman for AIME, presided at the banquet, held in the Netherland Hilton's Pavilion Caprice, Wednesday evening. After the presentation of the Percy Nicholls award to Dr. Lowry, Mr. Tobey introduced the main speaker, E. S. Fields, president of the Cincinnati Gas and Electric Company.

Mr. Fields spoke on "The Ohio River and Power Development," making the point that the "beautiful" or "muddy" Ohio—depending on its mood—holds the key to the industrial growth of this area. He quoted figures on the importance of water to industrial expansion.

He said: "A recent U. S. Geological Survey Report states that present use of water by industry is equal to 160,000 gallons a year for each person in the United States; that in the five-year period from 1950 to 1955 the industrial use of water increased 43 per cent; that most of the water used by industry was for washing and cooling; and that all but two or three per cent was returned to its source."

"It was here in Cincinnati," he said, "that the concept of controlling pollution of a whole river system was born. In 1948, the eight states of the drainage area

Solid Fuels Conference

entered into a pact creating the Ohio River Valley Sanitation Commission . . . Three fourths of the industries discharging effluents into the stream are meeting the minimum requirements established by the Commission."

Mr. Fields sketched the history and current progress of traffic on the big river, from the first navigational markings in 1842 to today's 1500-ton barges with their single tows approximating 1200 ft in length. He described the growth of the Valley's electric power, projecting ahead to 1970 when the generating capacity on the main stem of the Ohio River will approximate 21 million kw, consuming some 50 million tons of coal.

Another Continent

An entertaining feature of the final luncheon was the speech by F. W. Giesel, business manager of the *Cincinnati Post and Times Star*, who spoke on the situation in "Black Africa." From personal observation he was able to paint a picture of the dark continent. He feels that much of the present difficulty stems from the sudden intrusion of civilization, the lack of the necessary time for Black Africa to adjust to the inrush of European culture.

For the rest of the conference program, there was a scenic cruise on the Ohio River, joined by many members of the Cincinnati and Ohio Sections of the two societies, whether or not they were associated with the Fuels Division.

Availability List: Fuels—AIME Conference

THE papers in this list are available in separate copy form until Aug. 1, 1960. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 40 cents each to members; 80 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in books of ten, are $3 to members; $6 to nonmembers.

59—FU-1 Survey of Carbonizing Properties of American Coals, by D. E. Wolfson and G. W. Birge

59—FU-2 Factors to Consider in the Use and Application of Industrial Coals, by U. B. Yeager

59—FU-3 Use of Bench-Scale Tests to Predict Combustion Performance of Coals, by E. A. Zawadzki and Felix du Breuil

59—FU-4 Relationship of Coal-Ash Viscosity of Chemical Composition, by W. L. Sage and J. B. McIlroy

59—FU-5 Fireside Corrosion of Superheater and Reheater Tubing, by James Jonakin, G. A. Rice, and J. T. Reese

JUNIOR FORUM

From Student to Engineer Through Professional Development[2]

By John F. Duerst[3]

THE young engineer of today has command of every facility for molding his future to fit his best interests. It is the purpose of this article to demonstrate that the status of professional maturity in the engineer is not automatically awarded after a given length of time but is something that one must earn. It is not possible to become an "engineer" overnight simply by virtue of one's graduation. The slogan which recently caught my eye puts it quite aptly: "The only job where one starts at the top is in digging a hole." Many facets involved in reaching professional maturity after graduation are presented here.

Many of the young men who begin engineering studies have not the least idea of the duties of an engineer. For some clarification we may say that scientists strive to discover basic principles, and engineers apply scientific fundamentals in order to achieve practical results.

One of the most important requisites for success in engineering is a good foundation in the basic scientific and engineering funadamentals. But who is to say what should be studied? That is something the beginning student is not in a position to solve for himself; this would be like knowing the answer before solving the problem. Instead, the student must rely upon advice and information from those that have gone before him. The educational programs that are set forth generally reflect the thinking of the engineers in industry who have presented their views to the educational institutions in a sort of an intellectual feedback.

The young engineering graduate enters industry with only a smattering of what really makes things tick. Practical knowledge is something that can only be learned on the job; to teach the ways in which industry functions is an impossible task in school, since each industry has its own methods and procedures. The industrial viewpoint is that it is actually preferable for the engineering aspirant to receive his practical training on the job. Most industries are conscious of the need of placing engineers where they best fit, and make every effort to do so.

Training. There are numerous combinations of talents in industry which may be utilized. There is challenging work to meet the demands of every type and kind of student. The first task that may be assigned would generally be some sort of training assignment, that is, one in which the new employee would have every opportunity to orient himself in his new surroundings, and learn the function of the various related portions of the group.

Although the work at first may sometimes appear rather menial, it may be necessary as groundwork for later assignments. It is difficult to advance without a thorough understanding of everything that precedes and has led up to a higher position.

There is also a great wealth and storehouse of knowledge available. Many industries provide evening classes in all sorts of subjects from review of basic algebra to the most advanced theoretical technical courses, all at no cost to the employee. There are also tuition reimbursement programs for those who wish to further their formal studies; this is particularly convenient for those who wish to obtain advanced degrees. There are many engineers who benefited from these programs and have obtained higher degrees.

Professional Development. Few students realize that their professional development must continue long after graduation. Many companies recognize this need and provide courses to aid in this development. Most states require a number of years of experience for an engineer to obtain professional registration. For an engineer, this is a milestone for which to strive. It might be considered analogous to the internship served by a medical graduate before becoming a practicing physician.

In the engineering practice all sorts of unforeseen phenomena crop up. The mechanical engineer suddenly becomes a statistician, the civil engineer designs actuating mechanisms, and the aeronautical engineer finds himself checking electric analog circuits to solve a problem. This serves to illustrate that anyone with a thorough grounding in basic engineering fundamentals will realize

Chairman's Corner

THE executive group of the National Junior Committee for 1960 will consist of the following personnel:

Chairman: Norman J. Viehmann, Department 753, Western Electric Company, 1600 Osgood Avenue, North Andover, Mass.

Vice-Chairman: Donald E. Glessmann, Remington Rand Univac, St. Paul, Minn.

Secretary: Ernest T. Selig, Armour Research Foundation of Illinois, Chicago, Ill.

Members: John R. Berendes, Combustion Engineering, Inc., Chicago 3, Ill.

A. S. Goldstein, General Electric Company, Ithaca, N. Y.

H. Bernard Lindstrom, Washington, D. C.

Alvin H. Murphy, Lockheed Missiles and Space Division, Sunnyvale, Calif.

Sabino G. Merra, Arthur D. Little, Inc., West Cambridge, Mass.

Bill G. Welker, Youngstown 11, Ohio.

Gayle M. Wylie, Wright Machinery Company, Division of Sperry Rand Corporation, Durham, N. C.

Should you wish to take an active part in the work of the National Junior Committee contact Mr. Viehmann, chairman, for information regarding possible Committee appointments.

[1] Engineering writer, General Electric Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

[2] From a talk presented at the University of Cincinnati. The opinions stated are those of the authors and not necessarily those of the McDonnell Aircraft Corporation.

[3] Structural Methods Engineer, McDonnell Aircraft Corporation, St. Louis, Mo. Assoc. Mem. ASME.

that there are few basic differences between the engineering fields. For instance, the "shear flow" of the aeronautical engineer is merely a different aspect of the horizontal shear of the civil engineer.

Professional Societies. Professional societies also have their place in the development of the engineer. These societies provide an outlet for creative thinking and provide opportunities for the young engineer to write papers and to learn effective presentation. They also provide for business contacts which may prove useful when dealing with other companies. Not to be overlooked is the opportunity to see and speak with other engineers and exchange points of view. There is also an atmosphere of social congeniality that should not be forsaken.

Continuing one's education after graduation is no easy task; however, in large organizations, there are many programs which permit augmentation of education, as previously pointed out. This is helpful since it is difficult to pace oneself in such an enterprise and the financial difficulties of higher education are also somewhat alleviated.

Libraries. Another advantage of a large corporation is the availability of large library facilities. This, coupled with the regular libraries in many areas, provides immense storehouses of knowledge which are available for the asking. Other sources of information which may be mentioned are the various federal government and military organizations, all of which are prolific distributors of technological information. Through these sources one may obtain information on almost any recent development, including those having security classifications. Finally, let us mention the trade magazines and technical journals of the societies. These, too, serve the purpose of imparting information, and should be utilized.

The foregoing build-up with regard to training and industrial application serves a great purpose as time goes by. The development of professional ability increases as one's experience increases. The years of "internship" serve to provide the all-important training in maturity, judgment, and experience which is so necessary when one comes into a job requiring more responsibility. The individual may reflect upon the past and realize that he has missed or made the most of the many opportunities for personal improvement. It is difficult to appreciate advice at the time it is given. As pointed out, all of the prior formative years have gone into the molding of the engineer's character and maturity and professional ethics. The time has now come to begin placing all of these assets into play. The engineer who has learned his basic training, and who has put his time to good use, finds no difficulty in accepting increased responsibilities.

Having now laid the groundwork of the scholastic and the practical, and having gained in experience, we now find ourselves in the position of the mature engineer. The chances are extremely good that at this time we shall have certainly advanced somewhat (if not considerably) in position. One is now ready to determine responsible courses of action and to be a leader. One is now thoroughly familiar with the operations and machinations of one's company and can make important and quick decisions. The processes of reasoning are the natural by-product of the prior years of learning, research, and application.

Registration. Every state has set up a board whose function is to judge the qualifications of engineers and to officially register them to practice engineering. Many people believe that an engineer cannot be considered a professional until he is registered or, at the very least, until he possess the necessary qualifications for registration. The general idea of engineering registration, both from the practical point of view, and also from the viewpoint of technical success, is recommended regardless of whether or not one desires to enter a consulting practice at some later date.

The "successful" engineer is never really satisfied with "success" alone. He is happiest when he is working on something that can be of credit to the profession and to himself. Engineers at this time have two paths of advancement open to them. They can either consider advancing along a technological line, or they can go into management. Many companies have realized that there are quite a number of engineers with a scientific or a research bent, and have provided means for their continued advancement along purely technical lines. This provides an alternative course to the time-honored path through the managerial positions, which was the only way in the past.

Your future is up to you. You, alone, have control over your program of future development. Industry is happy to receive young graduates and furnishes a large selection of work from which to choose. The job experience builds up with practice and application. The industries themselves are glad to help the engineer advance in knowledge and training, frequently helping them out with tuition reimbursement programs and company courses. One may affiliate with one or more of the professional societies, attend meetings, learn about new developments, and utilize the opportunity to meet and speak with other engineers. One may chart and follow his own course of action which leads to the top.

For Engineers and Engineering Societies Too!

"It is difficult for a scientist, because of his proximity to the work, to judge properly a new scientific result in relation to the work of others, to progress in the whole field, and to important progress in related fields, or to fields that are competing in scientific interest with the author's field. The professional, scientific, and technical societies comprise in aggregate a supreme court of informed scientific opinion. The verdict of this court concerning the importance and significance of scientific work generally transcends the opinions of the author or the sponsors of the work. To be sure, the verdict may not be explicit nor prompt, but it is generally final and inescapable and of substantial significance to the career of the author and to the reputation of the sponsor.

"I would like to point out that the participation of a scientist as a contributor to the work of the technical societies also develops some important advantages for the sponsor. The sponsor of the research, whether it be an industrial, university, or government laboratory, shares in the recognition accorded the individual; and this is an important corollary benefit to both the scientist and the sponsor. From the standpoint of attracting capable people to the sponsor's organization, it is doubtful whether any public relations activity equals the effectiveness of the inherent public relations benefits that result from a policy of not only permitting, but encouraging, the prompt publication of scientific work."

Excerpts from "Recognition of the Scientist," a speech by C. G. Suits, Vice-President and Director of Research, General Electric Company, Schenectady, N. Y.

ASME COMING EVENTS

March 6–9, 1960
ASME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Texas.

March 14–15, 1960
ASME Lubrication Symposium, Engineering Societies Building, New York, N. Y.

March 31–April 9, 1960
ASME Textile Engineering Conference, North Carolina State College, Raleigh, N. C.

April 4–8, 1960
Nuclear Congress and Exhibit, Coliseum, New York, N. Y.

April 13–14, 1960
ASME-AIEE Railroad Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

April 21–22, 1960
ASME-SAM Management Conference, Statler Hilton Hotel, New York, N. Y.

April 25–26, 1960
ASME Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotels, St. Louis, Mo.

April 25–29, 1960
ASME Metals Engineering Division-AWS Conference, Hotel Biltmore, Los Angeles, Calif.

May 17–19, 1960
ASME Production Engineering Conference, Hotel Schroeder, Milwaukee, Wis.

May 22–26, 1960
ASME Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Mo.

May 23–26, 1960
ASME Design Engineering Conference and Show, Statler Hilton Hotel, New York, N. Y.

June 5–10, 1960
ASME Summer Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, Texas

June 20–22, 1960
ASME Applied Mechanics Conference, The Pennsylvania State University, University Park, Pa.

June 27–29, 1960
ASME West Coast Applied Mechanics Conference, The California Institute of Technology, Pasadena, Calif.

August 15–17, 1960
ASME-AIChE Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y.

September 7–9, 1960
ASME Instrument and Regulators Conference, Massachusetts Institute of Technology, Cambridge, Mass.

September 15–16, 1960
ASME Engineering Management Conference, Morrison Hotel, Chicago, Ill.

September 21–23, 1960
ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

September 26–28, 1960
ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans, La.

October 9–12, 1960
ASME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.

October 10–11, 1960
ASME-AIEE Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

October 17–19, 1960
ASME-ASLE Lubrication Conference, Statler Hilton Hotel, Boston, Mass.

November 27–December 2, 1960
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(For Meetings of Other Societies see page 117)

Note: Members wishing to prepare a paper for presentation at ASME National meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

Woman's Auxiliary to ASME Aids Woman Engineering Student

THE Woman's Auxiliary to the ASME for the first time selected a woman recipient for one of four $500 **Sylvia W. Farny Scholarships** awarded for 1959 to students graduating in June, 1960.

Carolyn F. Phillips, a 19-year-old student at Pratt Institute, Brooklyn, N. Y., belongs to the ASME Student Section. Her scholastic record is above average and her references are excellent.

Thomas T. Shishman, who was born and lived in Hungary until 1951, was naturalized in 1957; 21 years old, he is top student in his class at the University of Notre Dame, Notre Dame, Ind.

James L. Coggins, selected as the outstanding ROTC student in the College of Engineering, is on the Dean's list at the University of Alabama. He is 21, single.

Joseph B. Cichocki, State College of Washington, Pullman, Wash., is 29, married, with two children. He has been attending college under the G.I. bill which expired last June.

Mrs. George S. Gethen is Chairman of the Committee. Other members are Mmes. Ralph L. Goetzenberger, Crosby Field, William H. Larkin, and Arthur M. Gompf.

Calvin W. Rice Memorial Scholarship Fund. Candidates for the award of $1500 toward the expense of one year's graduate study in the United States in Mechanical Engineering, recommended by the Institute of International Education, were from Japan, Mexico, France, and The Netherlands.

The Scholarship was awarded to Hector Jasso of Mexico. He is 24 years old, single, and a graduate from the Institute of Technology in Monterrey, Mexico, where, in 1958, he was appointed professor in charge of machine design and mechanical technology in the Department of Mechanical Engineering.

Committee Members are: Mmes. A. R. Cullimore, Chairman, W. H. Byrne, G. T. Felbeck, J. W. Wilkenfeldt, and C. H. Young.

Student Loan Fund. In March, 1959, requests for loans depleted the funds and the Committee was obliged to refuse applications. By action of the National Executive Board at its May meeting, the sum of $1500 was transferred from the General Fund to the Student Loan Fund.

Loans are made to junior, senior, or graduate students of mechanical engineering in good standing, enrolled as candidates for a degree in a college or university in which there is a Student Section of ASME. The maximum loan is $500 and all loans are interest free while the students are in college. Upon graduation, the interest rate is 2 per cent for one year and 3 per cent thereafter until the loan is repaid in full.

To date in 1959, 23 loans totaling $9395 have been granted. There are 64 loans outstanding, representing original grants of $27,495. These loans were made to students in 27 colleges throughout the country.

Steve A. Wutzke

Committee Members with the Chairman, Mrs. Walter F. Friend, are: Mmes. Christian Bertelsen, H. R. Kessler, John C. Somers, and E. J. Sharkey.

Marjorie Roy Rothermel Scholarship. Steve Arthur Wutzke, who is working for his Degree in Mechanical Engineering at the University of Illinois, is the first recipient of the Marjorie Roy Rothermel Memorial Scholarship, an award of $750 granted by the Woman's Auxiliary to the ASME.

Mr. Wutzke was born in Sandwich, Ill., is 23 years of age, received his BSME in February, 1959, MSME from the University of Illinois, and hopes to receive his MSME in June, 1960. He won by examination the Illinois "County" Scholarship tuition for four years, was awarded University Honors four years, University of Illinois Scholarship Key, State of Illinois Engineer-in-Training (by examination Feb. 3, 1959), membership in Phi Kappa Phi, Pi Tau Sigma, Tau Beta Pi, and Sigma Tau. He also is ASME Student Section Treasurer, Football Band and 1st Regimental Band, YMCA International Friendship Committee, and has half-time assistantship in ME Power Laboratory. He is married.

This Educational Fund, a $750 Scholarship, was announced a year ago by the Woman's Auxiliary to be awarded annually to a graduate mechanical engineer for use in study toward an advanced degree in Engineering. It was named in memory of Marjorie Roy (Mrs. U. A.) Rothermel who became the twenty-first President of the Woman's Auxiliary on Jan. 1, 1957, and died in November of the same year, shortly after this Scholarship was initiated. It is, in addition to the Sylvia W. Farny Scholarship of $500, awarded to mechanical-engineering students for use in their final (fourth or fifth) year of study, and the Calvin W. Rice Memorial Scholarship is an award to a foreign student in mechanical engineering toward a year's graduate study in a college or university in the United States. A Student Loan Fund is also available to Junior, Senior, and Graduate students of Mechanical Engineering.

For additional information write to the Chairman of the Marjorie Roy Rothermel Memorial Scholarship Fund, Mrs. Frank W. Miller, 7805 Cobden Road, Philadelphia 18, Pa.

ASME Group Insurance

First Annual Report Issued

THE first Annual Report of the Administrator of the Group Insurance Program for Members of ASME, covering policy year starting June 1, 1958, and ending May 31, 1959, reveals that in its first year the program showed substantial participation by ASME members and gave every indication of continuing growth. Participation has already reached a high enough level to insure a sound and healthy program.

Analysis of applications received indicates that the Program is used by all types of ASME members and the percentage of applications received from various categories of members compares remarkably well with their proportionate representation in the Society. Government employees, educators, consulting engineers, and retired members made application for the Program in slightly higher proportion than their relative strength in the Society. However, approximately 38 per cent of the applications came from members employed by firms employing more than ten ASME members. Since it is probable that such firms were large enough to have group insurance programs of their own, it seems clear that these members found it desirable to supplement their company coverage with some part of the Program for ASME members.

Analysis of applications received during the six-month Charter Enrollment Period ending Dec. 1, 1958, showed that both the highest numerical and percentage participation came from members in the Sections of Region II, and the lowest numerical and percentage participation came from the members in the Sections of Region IV.

As of June 1, 1959, 193 claims had been paid. Twenty-eight claims were paid under the Loss of Time Plan, 149 were paid under the Major Hospital-Nurse-Surgical Expense Plan, and 16 claims were paid under the Senior Hospital-Nurse-Surgical Expense Plan. We believe that the American Casualty Company claim work has been quite satisfactory and that claims have received prompt, courteous, and equitable treatment.

Several months after the start of the Program the Administrator learned that some members would prefer to have the option of participating in the Senior Hospital-Nurse-Surgical Plan at a reduced premium with a $500 deductible feature. Accordingly, after due consideration by the Group Insurance Committee and approval by the Council, such an option was added to the Senior Plan.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council was held on Friday, Oct. 9, 1959, in the rooms of the Society.

There were present: G. B. Warren, *chairman;* E. W. Allardt, R. B. Smith, and A. W. Weber of the Executive Committee; Joseph Pope, Director; L. C. Smith, Organization Committee chairman; W. L. Cisler, President-elect; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; W. E. Letroadec, W. E. Reaser, S. A. Tucker, and J. D. Wilding, assistant secretaries; J. J. Jaklitsch, Jr., editor; H. I. Nagorsky, controller; D. B. MacDougall, associate head, Field Service.

The following actions are of general interest.

ASME Staff Members. In recognition of long service by staff, the Council extended to Edna Murrayes, member of the staff for 40 years, and Florence Schonger, member of the staff for 35 years, sincere appreciation of their loyal and faithful services and their valuable contribution to the success of the Society.

Council Member. *Replacement.* In accordance with action taken on Sept. 11, 1959, by the Executive Committee of the Council, a letter-ballot of the entire Council, closing Oct. 8, 1959, approved the acceptance of Vice-President Aurand's resignation and the appointment of W. C. Heath to fill his unexpired term from Oct. 15, 1959, to Nov. 30, 1959, as Vice-President of Region VII.

Council Policy. *Research Contracts.* At its meeting on Sept. 11, 1959, the Executive Committee of the Council noted the "Policy Governing the Conflict of Interest in Research Contracts" approved by the Board on Technology. To make this a Council Policy, action is required. The Executive Committee of the Council voted to approve the policy as a Council Policy under the number P-6.14.

Board on Membership. *ASME co-operate with other societies in promoting education of Engineering Aides.* The Board on Membership studied the revision of the definition of Associate Member as prepared by the Admissions Committee at its meeting on June 9, 1959. The members of the Board expressed themselves as not in favor of spelling out too specifically the requirements for the Associate Member grade. It was the general feeling that it is the Admission Committees prerogative to use its good judgment in reviewing applications and the procedures cannot be mechanized with too many hard and fast rules. Upon recommendation of the Board on Membership, the Executive Committee of the Council voted to request the Constitution and By-Laws Committee to modify Article C4, Sec. 5 in accordance with the approved definition of the requirements for Associate Member grade. And, further, to recommend to the Board on Membership and the Admissions Committee that a rule be formulated to permit credits toward the eight-year experience requirement for outstanding students from nonaccredited institutions.

Scope of Responsibilities. The Council voted to direct the Board on Membership to conduct a complete study of the membership growth of ASME, including the rate of increase, membership retention, and all other aspects of the subject; and to recommend that this study go far beyond the current study being undertaken by the Membership Development Committee; to recommend that the Board meet more frequently as a means of assuming its full responsibilities; and to request a progress report for the April 8, 1960, Executive Committee of the Council with a full report to the Council at the 1960 Semi-Annual Meeting in Dallas, Texas.

Future Membership Growth of the Society. In response to the directive of the Executive Committee of the Council, the Board on Membership appointed a subcommittee to study this matter in collaboration with the membership Development Committee. On Aug. 20, 1959, the Board on Membership transmitted its report to the Council. The Executive Committee of the Council voted to receive the report on membership growth and to refer it to the Board on Membership for use in the requested study.

Board on Honors. *1959 Awards.* The Board on Honors voted to grant the following 1959 awards: Arthur L. Williston Medal and Award to Rowe Angelo Ghirardini; Charles T. Main Award to James Lowell Benson; Undergraduate Student Award to Frederick C. Borjes; and Old Guard Prize to James S. Kishi.

Board on Education. *Guidance Brochure.* The Council authorized the distribution of "Mechanical Engineering and You," a pamphlet, for use in the guidance work of the Society; to include the statement, "This brochure supports the ECPD Guidance Program"; and to offer distribution of the brochure through ECPD at cost.

Board on Public Affairs. *Change of Personnel.* Upon recommendation of the Organization Committee, the Council requested the Constitution and By-Laws Committee to prepare the necessary amendment to Article B6A, Par. 19 to add the Junior Past-President to the Board on Public Affairs for a one-year term, and that this change be prepared for first reading at the 1959 Annual Meeting.

Research Executive Committee. *Research Agreement with Battelle Memorial Institute (ASME Project 7-DP-10).* Upon recommendation of the Research Executive Committee, the Council authorized the Secretary to execute the Research Agreement with Battelle Memorial Institute regarding the physical properties of iron, nickel, cobalt, and molybdenum conducted under the auspices of the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals.

Power Test Codes Committee. *1960 Chairman.* Upon recommendation of the Power Test Codes Committee the Council approved the extension of the term of Rawleigh M. Johnson as chairman of the Power Test Codes Committee for one year, expiring Nov. 28, 1960; and that he represent the Committee on the Board on Codes and Standards.

Sections. *Affiliation of the Central Illinois Section with the Peoria Engineering Council.* Upon recommendation of Vice-President Dolan, Region VI, the Council approved the affiliation.

Student Sections. *Change of Name.* The Society has been notified of the change of name of two state colleges: Iowa State College to Iowa State University, and State College of Washington to Washington State University. The ASME Student Sections on these campuses have been renamed accordingly.

Committee on Roosevelt Field Aviation Mural. The Council voted to discharge this Committee with appreciation.

Group Disability Insurance. *Report.* The seventh Progress Report on the Group Disability Insurance for ASME Members, covering the period from May 15, 1958, to Sept. 1, 1959, was noted (see p. 135).

Engineers Joint Council. *1960 Officers.* The Nominating Committee of EJC has submitted the following nominations to the EJC Secretary for the 1960 Officers: President, Augustus B. Kinzel (AIME), and Vice-President, Cecil Boling (ASHRAE).

National Science Foundation. On recommendation of EJC, the Council voted to support the renomination of Murrough P. O'Brien for another term on the Board of the National Science Foundation, and to nominate Eric A. Walker to replace Donald H. McLaughlin on the expiration of this term on the NSF Board in May, 1960, by letter to the President of the United States and to the Director of the NSF.

Joint Awards. *Daniel Guggenheim Medal.* It has been announced that the 1959 recipient of the Daniel Guggenheim Medal is Sir George Edwards of Surrey, England.

Certificate of Awards. *Board on Honors.* Upon recommendation of his associates and approval of President Warren, a certificate of award has been prepared for Abbott L. Penniman, Jr., who served on the Board, 1958–1959.

Medals Committee. Upon recommendation of the Board on Honors and Approval of President Warren, certificates of award have been prepared for the following retiring members of the Medals Committee: John R. Blizard, chairman; Crosby Field, Linton E. Grinter, Wil-

liam A. Hanley, Carl J. Oxford, Jr., Milton Shaw, George L. Sullivan, and Julian B. Thomas.

Regional Chairman. Upon recommendation of Vice-President Allardt, the following certificates are being prepared for Region V Committee Chairmen: Raymond L. Hollaway, Jr., secretary, 1957–1959; G. Ross Lord, Sections Committee, 1957–1959; George E. Pankratz, Student Sections Committee, 1957–1959; Henry R. Fulton, Jr., Professional Divisions Interest Committee, 1957–1959; Arnold H. Hoffer, Honors Committee, 1957–1959; Charles E. Jones, Education Group, 1957–1959; Harold M. Cather, Publications Committee, 1953–1959; Edwin W. Miller, Organization Committee, 1957–1959; J. David Carr, Manuals Committee, 1957–1959; James A. Brown, Membership Development Committee, 1957–1959; and S. M. Marco, M.E. Department Heads Committee, 1958–1959.

Faculty Adviser. Upon recommendation of Vice-President A. W. Weber, Region III, a certificate of award has been prepared for W. Francis Lindell, Faculty Adviser of the ASME University of Delaware Section.

Section Chairman. Upon recommendation of Vice-President Dolan, Region VI, a certificate of award has been prepared for the 1958–1959 retiring chairman, Marvin V. Maxwell, Chicago.

Appointments. ***Appointments to Boards Committees, and Joint Activities.*** Upon recommendation of the Organization Committee on Oct. 8, 1959, the Council approved the appointments.

ASME Council Actions on 1959 National Agenda Reported

How the National Agenda is compiled for Regional Administrated Committees and Items which are ultimately acted upon by Regional Delegates Conference

At a meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers, held at Society Headquarters, New York, N. Y., on Oct. 9, 1959, approval was voted of statements and actions on the recommendations of the 1959 Regional Delegates Conference submitted to the Council at the 1959 Semi-Annual Meeting, St. Louis, Mo., June 14, 1959.

These recommendations, the actions of the Regional Delegates Conference on them, and the actions or statements of the Council are reported in what follows. A detailed description of the procedure by which agenda items are prepared and acted upon by the Sections, the Regional Administrative Committees, the Regional Delegates Conference, and, finally, the Council follows the report on the 1959 recommendations.

Final Report on 1959 RDC Recommendations

Agenda Topic No. 47: Realignment of Regions VI, VII, and VIII: It is proposed that Regions VI, VII, and VIII be divided into five Regions.

Delegates Action: Approved 11 to 0.

Council Action: Upon recommendation of the Organization Committee, having concurred with the recommendation of the Delegates, the Council at the Sept. 11, 1959, meeting referred the matter of the realignment of Regions VI, VII, and VIII to the Constitution and By-Laws Committee for implementation.

Agenda Topic No. 63: Bring Several of the Operating Years of the Society Closer Together: It is proposed that a plan for more closely synchronizing the Section, Region, Division, Committee, Board, and Council years of the Society be adopted.

Delegates Action: Approved 12 to 2.

Council Action: Noting that the Organization Committee concurred with the recommendation suggested by the Vice-Presidents, the Council on Sept 11, 1959, requested staff (1) to prepare a chart (October, 1959) showing the proposed regional and administrative years of July 1 through June 30, (2) to discuss chart with the Vice-Presidents, at their meeting on Oct. 12–13, 1959, and when approved, (3) to submit to the sections for endorsement, as an item on the 1960 National Agenda.

Agenda Topic No. 2: Hold Annual Meeting Outside New York More Often: It is proposed that the ASME Annual Meeting be held outside of New York City more frequently than one year in every four.

Delegates Action: Approved 11 to 2.

Council Action: Council noted on Oct 9, 1959, that the Meetings Committee unanimously favor the proposal. However, prior commitments to Sections and hotels make it impossible to adopt the recommendation before 1965.

Agenda Topic No. 3: Information to Members: It is proposed that the Society formulate and execute plans for informing the membership more thoroughly of the organization and operation of the Society.

Delegates Action: Approved 9 to 5.

Council Action: The Council noted on Oct 9, 1959, that the following articles which relate to the operation of the Society have been published during 1959 in Mechanical Engineering:

- ASME's Research Committee Program, February
- ASME Committees, February
- The Professional Divisions of ASME, March
- ASME Publications, April
- Professional Divisions and the Associate Member, May
- Preparation of Papers for ASME Publications, July
- The ASME Boiler and Pressure Vessel Code, July

Other articles are planned. Also an account of the Technology Executives Conference, and the ASME Honors Engineers story, presenting descriptions of the various Society technical activities and Awards, are published in Mechanical Engineering each year.

Agenda Topic No. 19: Membership Certificate for All New Members: It is proposed that each new Associate Member and Member be given a Membership Certificate, suitable for framing, by the Society.

Delegates Action: Approved 12 to 3.

Council Action: The Council on June 14, 1959, adopted the amendment to Article R3, Rule 1, as follows:

> "Each member shall be entitled to a certificate of membership, signed by the President and the Secretary of the Society; it shall remain the property of the Society and be returned on request. The charge for this certificate is to be determined by the Council."

Agenda Topic No. 42: Interested Sections Establish Co-operation with Professional Divisions and Committees: It is proposed that the Sections which have organized interests that parallel those of the 24 Divisions, and the Solar Energy Application and Air Pollution Controls Committees take steps to establish a more effective liaison with these Divisions and Committees.

Delegates Action: Approved 11 to 3.

Council Action: The Council, at its Oct. 9, 1959, meeting in concurrence with the recommendation of the Delegates, voted to transmit the 1960 issue of the Directory or Technology Personnel (AS-2) to the Sections and Divisions with a transmittal letter suggesting closer co-operation between the operation of the Sections and

the national technological services of the Society. The Directory of Regional and Section Personnel (AL-1) is also sent each July to the Divisions and Sections to enable representatives of each to correspond directly.

Agenda Topic No. 48: Section and Regional Reports Be Made Only at RAC: It is proposed that ASME eliminate annual reports of Sections, Regional Committees, and Vice-Presidents now required by August 31 and place these reports in RAC Minutes.

Delegates Action: Approved 15 to 0.

Council Action: Council concurred in the February, 1959, action of the Vice-Presidents to eliminate "the 150-word reports from the Sections" from their annual reports to Council effective 1959. Therefore the annual reports of the Sections were included in the minutes of the 1959 RAC meetings. The Council, at its Oct 9, 1959, meeting, voted, subject to approval by the Vice-Presidents, to approve the inclusion of annual reports of Regional Committees and Vice-Presidents in the minutes of the RAC Meetings; these minutes to become a part of the master copy of the annual reports to the Council. Subsequently, on October 13, the Vice-Presidents voted to recommend to the Council the approval of Agenda Topic No. 48 of the RDC Minutes.

Agenda Topic No. 58: Council to Co-operate in Formulating Program for Engineers' Week: It is proposed that Council should seek to co-operate with other technical societies and NSPE in formulation of a program for Engineers' Week.

Delegates Action: Approved 14 to 0.

Council Action: Council, on Oct 9, 1959, after noting previous efforts of the ASME Public Relations staff to obtain the co-operation of other Founder Societies in the development of posters and displays for use by Sections of the Founder Societies in support of Engineers' Week, voted to urge the Founder Societies to join in supporting recognition of engineers at the Section level during Engineers' Week.

Agenda Topic No. 59: Council Continue Its Efforts to Promote Unity: It is proposed that Council continue its efforts to promote lasting Unity in the engineering profession by seeking a basis that would be mutually acceptable to EJC, ECPD, the Founder Societies, and NSPE. In doing this, Council is urged to recognize the special interests and talents of EJC in the technical area, ECPD in the education area, and NSPE in the professional area.

Delegates Action: Approved 13 to 0.

Council Action: On Sept 11, 1959, the Council, concurring with the recommendation of the Delegates, voted that the Council of ASME, mindful of the unanimous recommendation from the ASME Regional Delegates Conference as of June, 1959, which reads as follows: "It is proposed that Council continue its efforts to promote lasting Unity in the Engineering Profession by seeking a basis that would be mutually acceptable to the Engineers Joint Council, the Engineers' Council for Professional Development, the Founder Societies, and the National Society of Professional Engineers. In doing this, Council is urged to recognize the special interests and talents of EJC in the technical area, ECPD in the educational area, and NSPE in the professional area" (this is almost a repetition of the recommendation given ASME Council by the 1958 Regional Delegates Conference), and recognizing the urgency and importance of establishing Unity of the engineering profession and wishing to see action rather than discord, the Council withholds approval of the proposed merger of the Engineers Joint Council and the Engineers' Council for Professional Development, and recommends instead (1) that the present Task Force of Presidents be asked by the Founder Societies to agree on a suitable Unity program by Dec 31, 1959; failing this, (2) to recommend to the Founder Societies the appointment of a new Task Force to be charged with the development of a constructive Unity program by June 3, 1960; (3) if neither (1) nor (2) are productive, then ASME Council wishes to put the societies on notice that ASME may take action with such other societies as wish to effect as much of a Unity program as possible in the immediate future, and (4) that President Warren notify the other Founder Societies of this action and urge them to take similar action.

Items Rejected

To complete the record, the following item that appeared on the agenda for the Regional Delegates Conference was rejected: No. 70.22.81, ASME Support a Program for Improvement of Patent Laws.

Nominations for ASME Honors

MEMBERS and agencies of The American Society of Mechanical Engineers including Boards, Committees, Sections, and Professional Divisions—except members of the Council and the Board of Honors, are invited to submit nominations for Society honors and awards as described in the ASME Honors Manual MS-71. Nominations for 1960 must be in the hands of the Board of Honors prior to March 1, 1960.

As important changes have been made in the nominating procedures and the Manual, it is *essential* that those wishing to make a nomination secure a copy of the Honors Manual dated October, 1958, with the Errata Sheet for 1959, by writing to the Board on Honors, ASME, 29 West 39th Street, New York 18, N. Y. Please note carefully information given on pages 3, 6, 11, 12, 13, 14, and the Errata Sheet, particularly Appendix I.

ASME Procedure in Preparing and Discussing Agenda Items

THE American Society of Mechanical Engineers has developed a procedure whereby action is taken by all Sections on suggestions made by any Section to improve policies, procedures, and operations of the Society. This procedure starts with the compilation by the National Agenda Committee of preliminary statements of the items suggested. If one third of the Sections approve any one item, it is included in a National Agenda for discussion at Regional Administrative Committee meetings held in the spring.

Further discussion at a national level takes place at the Regional Delegates Conference held during the Semi-Annual Meeting. The results of this Conference are then submitted to the Council.

The principal business of the Regional Delegates Conference held during the Semi-Annual Meeting is to consolidate the actions of the eight RAC meetings on the National Agenda and to report the consolidated view to the Council. Related matters frequently arise on which a consolidated view is developed, or on occasion the Council may request the opinion of the RDC on a Society policy or procedure. The Council is usually in session at the same time as the RDC and provision is made for the Delegates to attend the Council Meeting.

A report of the actions of the Conference is made to Council during the Semi-Annual Meeting. The Council after studying the recommendations of the RDC refers to the various administrative agencies of the Society the different items with which those agencies are concerned.

After considering comments received from the administrative agencies, the Council acts on the recommendations of

the RDC. These actions were reported to the Delegates and Section Executive Committees on Oct. 9, 1959. They also are reported in MECHANICAL ENGINEERING as soon thereafter as possible. Thus the cycle from origination of items by the Sections to a reporting of actions by Council is completed within one year.

Compilation of the National Agenda

About September 1 of each year, the chairman of the Agenda Committee sends forms to the Sections and requests the submission of items by the end of October.

Upon receipt of the items, the Agenda Committee reviews them, corresponds with the suggesting Section, and refers the items that can be dealt with promptly as administrative matters to the proper administrative agency.

On December 18, a compilation of all items accepted by the Agenda Committee will be sent to the Sections for an expression of opinion as to inclusion in the final agenda. By Feb. 1, 1960, the Agenda chairman must have all the opinions. One third of the Sections must approve an item before it can become a part of the National Agenda, which is sent out to all the Sections at least four weeks in advance of the first RAC meeting.

Action in the Sections

The National Agenda requires action in the Section Executive Committee on at least three points:

A In the original suggestion of items. In this process it is desirable to canvass member opinion by some method, by mail, or at a Section meeting.

B The expression of opinion about including an item in the National Agenda.

C A determination of the position the Section is to take on the items in the National Agenda.

It is generally desirable for the Section to select its representatives to the RAC meeting at an early date so that they may be in touch with the entire process of developing the National Agenda.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

The application of each of the candidates listed below is to be voted on after Dec. 24, 1959, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

ALLEN, WILLIAM K., Birmingham
BARROW, REESE A., Birmingham
BRICKELL, MANUEL C., Birmingham
GRIFFIN, WILLIAM P., Birmingham
HARRISON, WALTER L., Birmingham
● POOR, WILLIAM R., Birmingham
SMITH, CLIFTON R., Mobile
WALTON, WAYNE P., Birmingham

Arizona

MARCOUX, HELIODORE A., Tucson

California

● ADLESON, IRWIN J., Northridge
D'ARCY, ANTHONY N., Huntington Park
HERAK, JOHN P., San Francisco
LEIGHTON, ARTHUR W., Los Angeles
MARSH, HARRY P., Berkeley
MCGARRY, JOHN F., Oakland
NAGEL, ROBERT G., Edwards AFB
NELSON, LYLE A., Tarzana
SHERMAN, HARVEY, La Mirada

Connecticut

BARTRAM, RICHARD G., Torrington
BLANK, HARRY E., Jr., Norwalk
MALKIN, BRUCE M., Stamford
● MCMULLEN, JAMES F., Hamden
WICKSTRAND, NORMAN M., Torrington

Florida

BINNS, ROBERT A., Pensacola
● FURLONG, THOMAS F., Pensacola
● HINES, ANDREW H., JR., St. Petersburg

Georgia

BLACK, MILES F., JR., Savannah
ZANETICH, PETER, Dobbins AFB

Idaho

NEWHARD, JACK W., Idaho Falls

Illinois

ANDERSON, PETER D., Carbondale
DAY, RICHARD A., Peoria
DEGERSTROM, JAMES M., Berwyn
JOSLIN, WILLIAM M., Chicago
● PALMER, FRANK A., Joliet
ROGERS, KENNETH A., Chicago
SIVERTSEN, CLAYTON L., Rolling Meadows

Indiana

● BECK, NIELS J., Columbus
HARTSAW, WILLIAM O., Evansville

Kentucky

CARNAHAN, KENNETH M., Paducah

Louisiana

MANN, LAWRENCE, JR., Baton Rouge
MCKAY, HUNTER, 3RD, Shreveport

Maryland

CORBY, ROBERT M., Rockville
NAUGLE, GLENN L., Kensington

Massachusetts

BROGDEN, ROBERT K., Boston
● KIRKPATRICK, RAY B., Pittsfield
PEARSON, JOSEPH K., Andover
● REED, MALCOLM E., Westwood
RICH, ABRAHAM M., Brookline
VON LOESECKE, PAUL H., Needham

Michigan

● BUSCHELL, ROBERT N., Jackson
CENKO, STEVE, Flint
CHAPMAN, WILLIAM I., Birmingham
GRAEBEL, WILLIAM P., Ann Arbor
KIGAR, DONALD F., Detroit
MERCURE, ROBERT A., Detroit
REGELBRUGGE, ROGER R., Jackson
SMITH, RALPH E., Ecorse
TAYLOR, RICHARD L., Jackson
● WANLESS, JAMES W., Detroit

Mississippi

YOCUM, JOHN C., Pascagoula

Missouri

CALDWELL, GLENN E., Kansas City
CALLES, ROBERT M., Kirkwood
● OVERLY, ELTON A., Hickman Mills
WYSS, RALPH G., Kansas City

Montana

MULLIKIN, HARWOOD F., Bozeman

New Jersey

ROSSI, ALEXANDER S., Boonton
WANMAKER, RICHARD W., Maplewood

New York

BECKMANN, RUDOLF R., New York
● BREITMAN, BERNARD S., Bronx
CUYLER, KENNETH W., Olean
BRAENKEL, ALPHONS, Yonkers
● FRELINGER, JOHN E., Bethpage
GAMIEL, EUGENE R., New York
HASKELSON, PIERRE A., Flushing
HEDRICK, GEORGE E., JR., Wellsville
● HOWELL, HARVEY L., Huntington
● JACHIM, ROBERT, New York
KELLIS, GEORGE E., New York
KLAVUHN, JOHN G., Wellsville
● KNIGHT, DOUGLAS G., White Plains
LEVINE, CHARLES H., Utica
MIRABAL, JULIUS A., Burnt Hills
● PLOUGH, HOWARD V., Wellsville
ROSS, FRED J., Wellsville
● SIRECI, ANTHONY R., New York
WANG, CUO-SUI, Jamaica

Ohio

DIMARE, STEVE A., Akron
GORMLY, M. W., Cincinnati
KAPPUS, PETER G., Cincinnati
KASTURI, T. S., Cleveland
● LINSKER, EUGENE, Dayton
MCCARTHY, EUGENE R., Cleveland
MCNINCH, JOSEPH H., JR., Columbus
PETROFF, RONALD P., Akron
PRIMEAU, JOHN J., Euclid
● SAMUEL, BILLY P., Cincinnati
SCHILLING, WILLIAM J., Columbus
SMITH, JOHN A., Columbus
TATA, ROBERT P., Cleveland
USISKIN, CLIVE M., Cleveland

Oklahoma

DOTY, WILLIAM C., Oklahoma City
● MARESH, HERBERT D., Bartlesville

Pennsylvania

BENNETT, LAWRENCE B., Philadelphia
● BITTING, CARROLL H., Temple
CHIU, SU SHING, Berwick
● DAVIS, JOHN R., Morton
ERDOGAN, FAZIL, Bethlehem
EVANS, MILTON C., Devon
MAURER, JACK R., Brackenridge
MCGRATH, RICHARD J., Dalton
OLSEN, LAWRENCE K., Erie
● PEASE, BRADFORD K., Allentown
● PERKINS, PORTER H., Pittsburgh
SOMERS, EDWARD V., Pittsburgh
TATE, EDWARD, Williamsburg
TORTLIKE, WILLIAM, Erie
● WEARN, JAMES P., Philadelphia
WHITNEY, ROBERT L., Oakmont
● ZURN, FRANK W., Erie

Rhode Island

ADAMEDES, THOMAS C., Newport

South Carolina

KARST, WILLIAM B., Greenville

Tennessee

● JAMISON, KENNETH E., Knoxville

Texas

● CUNNINGHAM, DALE E., Dallas
● GASPERI, RAYMOND J., Pasadena
GOODWIN, VERNON H., Jr., Baytown
HOSNY, AHMED N., Houston
● HOWELL, ROBERT C., Pasadena
KERR, JAMES A., Dallas
● KORMAN, JOHN G., Bishop
MILAM, CHARLTON J., Richardson
STEWART, BYRON G., Bellaire

● Transfer to Member or Affiliate

● STRUNK, CHESTER L., Houston

Utah

WILDEY, LIONEL G., Salt Lake

Vermont

VERCOE, MAURICE C., Burlington

Virginia

● HANKINSON, THOMAS W. E., Hampton
MINTON, AUGUSTUS M., Falls Church
PLUMMER, WADE S., Falls Church

Washington

DAVIS, GEORGE E., Seattle
MURPHY, RAYMOND W., Spokane
NORTON, ROYALL E., Seattle

Wisconsin

KELLENBERG, WILLIAM A., JR., Fond du Lac

Foreign

BULLOCK, KEITH J., Brisbane, Queensland, Australia
CHIAS, MANUEL O., Madrid, Spain
COTTERILL, LEONARD J., Ahmadi, Kuwait, Arabia
● CSATHY, DENIS, St. Catharines, Ont., Canada
DANIEL, SOLOMON M., Pointe Claire, Que., Canada
FORMOSO, JOSE V., Mexico City, Mexico
GAUTHIER, LOUIS M., Sherbrooke, Que., Canada
HLA, KYAW, Rangoon, Burma
RANKIN, DOUGLAS B., Montreal, Que., Canada
● ROGERS, IVOR, C., Toronto, Ont., Canada
RUIZ, CARLOS, Stockport, Cheshire, England
STRIK, WILLIAM L., London, Ont., Canada
TALTON, GEORGE M., Palembang, Sumatra, Indonesia

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

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Men Available[1]

New York Office

Administrative Engineer, BSME, MSIE; 34; 12 years as management instructor, industrial engineer, operations co-ordinator, engineering planner, sales administrator. Desires position co-ordinating engineering, manufacturing, and marketing activities. Northern N. J., metropolitan New York. Me-763.

Petroleum-Refinery Engineer, 11 years' experience in engineering, maintenance, and construction of petroleum refineries, pipelines, and terminals. Desires position with oil company or construction of petroleum facilities. U. S. or foreign. Me-765.

Plant Engineer, licensed; 45; 25 years in the engineering field. Design, construction, and operation of steam-electric plants. Resident engineer, superintendent of steam-electric stations. East Coast, preferably N. Y. or N. J. area. Me-766.

Engineer for executive or managerial level in foreign sales, ME; 32; sales engineering in foreign countries and in U. S. in power-plant equipment and heavy machinery, also market studies and high-level contacts; eight years' experience. U. S. or foreign residence. Me-767.

Chicago Office

Mechanical Engineer, power-plant design or operation and maintenance, BSME; 39; approximately seven years' experience operating and maintaining power plants (marine and shore based); eight years' consultant for design, specification, operation, and maintenance of power plants and boiler plants. Midwest or West. Me-1004-Chicago.

Plant or Project Engineer, BSME, Univ. of Michigan; 36; PE. Seven years' design and project engineering experience in power generation, pulp and paper, and auto-assembly plants. Broad background in facilities design and construction for 14 plant operations. Southeastern Mich. Me-1010-Chicago.

Research and Development Engineer, BSME; 32; headed product development department for large valve manufacturer. Experienced in hydraulics, heat transfer, acoustics, mechanics. Knowledge of metalworking, plastics, and ceramics industries. Demonstrated ability in new product development. Chicago area. Me-1014-Chicago.

San Francisco Office

Assistant Manager of Operations, BSME; 38; 13 years' diversified experience in engineering, estimating, and manufacture of custom-built steel products. Ability to seek and evaluate problem areas. Experience in planning and co-ordinating activities at department head level. $12,000-$15,000. Prefers San Francisco Bay area. S(M)-1293.

Tool or Production Engineer, ME(Canada); 40; eight years' experience tool and production planning, senior processor of sheet-metal assemblies, forming, welding equipment, jigs, fixtures, heat-treatment for aircraft and auto-truck manufacturers. One and one half years' experience production of railway-rolling equipment. $6000. Prefers any U. S. or Canadian location. S(M)-1291.

Plant Engineer, BSME; 30; two years' Civil Engineering Corps (Navy) experience in construction-equipment maintenance, repair shops production and quality control, plant layout. Two years tool planning and design, welding, jigs and fixtures for auto industry. $6600. Prefers San Francisco Bay area. S-(M)-1270.

Maintenance or Senior Process Engineer, MSME; 38; two and one-half years senior process engineer, supervising chemical, mechanical, electrical engineers for operation of power plants, design and operation of pumping stations and petroleum-bulk plants, pipelines, water systems for petroleum companies. Ten years advising management and directing work on new facilities and operating practice of steam and water-treatment plants. $12,000. Prefers West. S(M)-1197.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members; $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

Estimator, Maintenance, or Inspector, BSCE; 33; four years' experience chief estimator, project supervisor, and engineering inspector on construction of petroleum refining and chemical plants, airbases and facilities, petroleum pipeline, tank farm and pumping-station facilities for consultants. Six and one-half years maintenance and equipment inspector, planning, co-ordinating maintenance and construction, estimating materials, labor and equipment for petroleum refinery. $9600. Prefers foreign or South or West U. S. S(M)-1220.

Marine Architect, MS NavArcht; 50; 20 years' experience in charge of design, planning, estimating, supervision of drafting, inspection, construction, contracting of shipbuilding, repair and alterations for Navy. Professional Mechanical and Industrial Engineers Licenses. $13,500. Anywhere U. S. S(M)-1185.

Mechanical Designer, BSME(England); 28; one year's experience design, development estimating of parking meters and aircraft instrument-test equipment. Three and one half years supervising small drafting office, machine shop, and technicians on development of welding equipment. $6600. Prefers San Francisco Bay area of Calif. S(M)-936.

Junior Mechanical Engineer, BSME; 26; Recent graduate would like starting position. $5400. Any location. S(M)-800.

Industrial Engineer, BS Engineering, 40; industrial engineering, cost reduction and control, methods, plant layout. incentives, job evaluation, and production control. Background of 16 years' industrial and management engineering including seven as company chief industrial engineer. Desires challenging management assignment. $12,000. Prefers San Francisco Bay area. S(M)-539.

Junior Mechanical Designer, BSME; 27; experienced on structural metals research, development, servicing aircraft-design groups, layout and design of air-conditioning, heating, and plumbing systems. $6600. Prefers Southern Calif. S(M)-565.

Production of Process Engineer, BSME; 30; one year systems supervision, testing, maintenance, operation of guided-missile equipment. Four and one half years process and production of domestic heating controls for manufacturer. $9000. Prefers San Francisco Bay or Seattle. S(M)-542.

Chief Industrial Engineer, BS Engr-Petro; 40; 19 years chief industrial and production manager for manufacturer of structural honeycomb (aluminum, fiberglas, paper), metal containers, steel and food processing. $10,000. Prefers San Francisco Bay area. S(M)-539.

Designer or Maintenance Engineer, 51; experienced on design of heavy machinery, dredges, piping and valves, power plants, and materials-handling equipment. Technical supervision over selection, installation, and maintenance of many types of mechanical and electrical equipment. $8400. Prefers San Francisco Bay area. S(M)-500.

Sales Manager, IE; 42; solid academic base with 20 years sales and sales management nationwide covering broad market with strong emphasis on engineered proprietary product and major job-shop operation. Well-rounded production and general organizational background. $12,000-$15,000. Prefers, San Francisco Bay area or Calif. S(M)-421.

Production, Research, or Development Engineer, BSME; 37; five years directing engineering, design, modelmaking, shop experimental production and unit fabrication, tests on auto hardware, vending-machine components, and furnace manufacture; two years engineering procedures, systems, records for packaging ma-

[1] All men listed hold some form of ASME membership.

chine and jet-engine component manufacturer; also two and one half years' research, design, development on overhead hoisting equipment. $13,000. Prefers South or West. S(M)-399.

Sales or Production Engineer, BSIE; 27; three years in charge of shipbuilding and repair through control of job orders, specifications, contracts, tests, production control for Navy (completed). Two years trainee in manufacture and sales of heavy machinery for manufacturer. $6000. Prefers San Francisco Bay area or West Coast. S(M)-378.

Mechanical Designer, BSME(Canada); 38; widely diversified experience in light manufacturing and mechanical design, with considerable experience in plant and process layout. Salary open. Prefers San Francisco Bay area. S(M)-346.

Positions Available

New York Office

Faculty Positions for teaching mechanics of solids and fluids on the undergraduate and graduate levels. Qualifications for and interest in research also desired. Minimum educational level is master's degree; PhD desired. Salaries and academic rank commensurate with education and experience. Southeast. W-8151.

Senior Engineer, Applied Mechanics, recent graduate MS or PhD, or several years' experience. Analytical ability desired. Position is with small consulting firm doing business in wide variety of fields, including missile and submarine vibration problems. Salary open. Relocation costs paid. Mass. W-8149.

Plant Engineer, graduate mechanical, three to ten years' experience in general plant engineering; experience in general plant design and in selecting equipment. Experience should cover several of the following: Plant layout, plant electric-distribution systems, steam-distribution systems, electric power and steam generation, heating and lighting systems, ventilation and dust collection, conveying and material handling, equipment foundations, refrigeration systems, motor drives and controls, etc. $7500–$8300, to start. Some travel. Headquarters, northern N. J. W-8148.

Designer, about 30, mechanical-engineering graduate, experienced in the design of air-conditioning systems, and some experience and knowledge of the problems of sheet-metal fabrication. Will be responsible for the design and application of air-conditioning accessory equipment. $8000–$10,000. New York suburban area. W-8134.

Product Development Engineer, mechanical graduate, specific experience in automotive-fastener field. $8000–$10,000. Conn. W-8133.

Senior Product Engineer, mechanical or chemical-engineering graduate, at least five years' product design, development, and processing experience in plastic, resins, adhesive, or rubber fields. $8000–$10,000. Ohio. W-8129.

Production Manager, college background preferred, at least two years' supervisory or production managerial experience in plastic-insulated wire and cable manufacturing. Must be familiar with extruding, spark testing (respooling), twinning, bunching, quadding, cabling, lacquering, striping, braiding, and related planning. Will report to plant superintendent. Will supervise several department foremen and must be capable of administrative organizing. To start, $7500–$9000, depending upon experience and background. Conn. W-8122.

Assistant to Manager, Export Department, graduate engineer, some foreign language proficiency desirable; to 30, one to three years' experience. Will assist in handling distributor needs, quotations, information on products and their application, etc. Also will undertake activities to better overseas distribution as well as study and evaluate firms that would be prospective distributors. Some travel overseas after training. $7000–$7500. Midwest. W-8105(*a*).

Sound-Control Engineer, MS in mechanical, electrical engineering, or phyics, advanced work in area of sound and vibrations preferred; 25–35; experience in sound and vibration field. Will devise methods for sound and vibration control of all products, develop methods and instrumentation for measuring sound-power levels and vibration, and interpret and evaluate sound and vibration measurements. $8000–$10,000. Midwest. W-8103.

Plant-Maintenance Engineer, 35–45, to supervise all building maintenance, repairs, grounds maintenance, janitorial services, procurement of

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE (e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.) | NATURE OF WORK DONE

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

I subscribe to

Address changes effective when received prior to:

- ☐ MECHANICAL ENGINEERING — 10th of preceding month
- ☐ *Journal of Engineering for Power*
- ☐ *Journal of Engineering for Industry*
- ☐ *Journal of Heat Transfer*
- ☐ *Journal of Basic Engineering*
- ☐ *Journal of Applied Mechanics* — 20th of preceding month
- ☐ *Applied Mechanics Reviews* — 1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

- ☐ A—Aviation
- ☐ B—Applied Mechanics
- ☐ C—Management
- ☐ D—Materials Handling
- ☐ E—Oil and Gas Power
- ☐ F—Fuels
- ☐ G—Safety
- ☐ H—Hydraulics
- ☐ I—Human Factors Group
- ☐ J—Metals Engineering
- ☐ K—Heat Transfer
- ☐ L—Process Industries
- ☐ M—Production Engineering
- ☐ N—Machine Design
- ☐ O—Lubrication
- ☐ P—Petroleum
- ☐ Q—Nuclear Engineering
- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

outside contractors, production, and distribution of steam, electricity, compressed air, etc. Will consult on all engineering projects and construction. Will be responsible for maintenance of company-transportation equipment. Manage receiving and warehousing operations; maintain communications equipment. $9000–$11,000. Married; no young children. Caribbean area. F-8092.

Chief Design Engineer, mechanical or aeronautical-engineering graduate, at least eight years' design and development experience on large axial and centrifugal fans. $10,000–$14,000. Midwest. W-8079.

Project Engineers, degree in mechanical, electrical, chemical, or metallurgical engineering, at least five years' design, development experience on products of a small close tolerance nature for use in hydraulic and pneumatic systems. Familiar with Military standards and production procedures. Should have previous experience in machine shop and on drawing board. Work will include design of new products, redesign and determination of new applications, feasibility studies. Activities will range from inception of ideas through design, modelmaking, testing, and marketing. $8100–$9367. Vicinity of Newark, N J. W-8067.

Engineers. (*a*) Design engineer, graduate mechanical or equivalent, experienced in the design, development, and standardization of small electromechanical components. (*b*) Methods engineer, graduate mechanical or equivalent, experienced in the methods and processes for the manufacture and assembly of small electromechanical components. Company manufactures temperature controls, circuit breakers, and related devices. Newark, N. J. area. W-8052.

Engineers. (*a*) Production engineers, graduate mechanical, minimum of four years' experience, to be responsible for all phases of manufacturing engineering from final design stage to successful completion of project through final testing. Should be familiar with engineering design methods, tools, and economic manufacturing processes. Will co-ordinate tool engineering and production-engineering activities; act as liaison during pilot manufacture, etc. $7200–$11,000. (*b*) Process engineer, graduate mechanical, minimum of five years' experience in machine tools and processes, to act as a project leader and be responsible to tool engineer for part and assembly processing, basic tool and gage design, procurement and the successful operation of tools in service, prepare cost estimates for tooling and manufacturing of parts of complete units, etc. To $10,000. Company pays placement fees and aids in relocating. Upstate N. Y. W-8040.

Manager of Manufacturing, 35–40, degree in engineering or business administration, for a company specializing in sheet-metal products for buildings, offices, schools, and libraries, to supervise all line and staff functions pertaining to the actual manufacturing of the products. Must have knowledge of basic staff functions related to manufacturing such as industrial engineering, scheduling and production control, material handling and storage, contract negotiations and interpretations, shipping and raw material storage, etc. $12,000–$15,000. South. W-8034.

Cost Analyst, 22–35, graduate in industrial engineering, practical training in cost accounting for cost-analysis work in general operations office of a multiplant company engaged in quarrying, mining and manufacture of cement, lime, and other rock products. Experience in cost control desired. South. W-7948.

Engineer for large, progressive, multiplant graphic arts firm; graduate engineer, of mature judgment with up to five years' industrial-mechanical-engineering experience. Job functions include plant and manufacturing engineering and general survey work for top management. Plant layout, materials handling, equipment specifications, replacement and automation, plus methods improvement and economic analyses are included. Good salary; opportunity for advancement. Approximately 75 miles from New York City. W-7945.

Chicago Office

Piping Designer, graduate mechanical desired but not essential; to 50; four years' experience in industrial piping design. Duties will include design and layout piping systems in connection with oil refineries, chemical plants, and power plants for a consulting engineer. To $8400. La. C-7773(*b*).

Product Engineers, BSME, to create and design new products or improve existing products utilizing a staff of process engineers, draftsmen, and technicians. Direct fabrication and test evaluation of bread board and prototype models, relative to operation, structural strength, endurance, styling, and compliance with specifications. Provide technical assistance. Assist in market analysis to define products, operational specifications, growth potential, sales and price. Recognize and relate associated considerations of finance, investment, production facilities, corporate technical competence to sales, manufacturing and engineering of hydraulic pumps, valves and cylinder. $9000–$13,000, depending on experience. Southern Wis. C-7776(*a*).

Senior Development Engineer, electrical or mechanical graduate; to 50; must have creative and analytical ability to design and build sample controls with new functions or lower costs which can be basis of new appliance controls. Experience in low-cost, mass-production devices. $9600–$15,000. Employer will pay placement fee. Ill. C-7768.

Superintendent of Equipment Layout and Installation, graduate mechanical; to 45; with at least five years' experience in field of container production, automatic packaging, or related field. Considerable experience in afore-mentioned as well as good knowledge of high-speed conveyers, machinery layout, control circuits, and drive details. Will supervise departmental activities in layout and installation designs on equipment and plant services such as gas, compressed-air systems, etc. Consult with contractors and company personnel regarding design and installation of equipment and changes on existing facilities. Follow progress of equipment installation and all facilities to insure that work is progressing according to schedule. Will supervise work of two project engineers on design layouts for machinery installation and developing technical data and designs for container conveying equipment; also the work of eight draftsmen responsible for detailing of layouts for container-making machines, conveyers, runways, drive details, control circuits, oven installation, spray equipment systems, gas and compressed-air systems. Potential development to manager of equipment, ayout and installation department. $8400–$12,000. Employer will pay fee. Chicago, Ill. C-7740(*b*).

Professor of Mechanical Engineering, PhD or equivalent, to teach at undergraduate and graduate level and do research in the general area of machine design. Areas of interest may include dynamics of machinery, vibration, bearings, and lubrication, etc. $10,000–$12,000. Employer will pay placement fee. Ill. C-7736.

Design Engineer, mechanical or electrical graduate; to 45; at least three years' experience in heating control or electrical mechanical controls and timers. Must have creative ability to work on heating controls, domestic furnaces, special switches, small mechanisms, for a manufacturer. To $10,000. Employer will pay placement fee. Ill. C-7669.

San Francisco Office

Project Designer, ChE and ME; to 50; five to ten years' substantial experience in design and directing consulting. Work on refining or chemical plants. Thoroughly familiar with mechanical work and equipment in process-type plants, handle whole job without direction for consultant. About $9600. Local Los Angeles man. Los Angeles. S(P)-4821.

Engineering Adviser, ME preferred, 30–55; seven to ten years' professional or management-engineering experience in industry or university-level teaching plus industrial employment or consulting practice. Must have minimum of one year dealing with foreign nationals in foreign country. Knowledge of common shop practices and procedures, general purpose machinery, preferably with metal; experience in tool design of modification of production equipment desirable. Work with economists, local government leaders, and individual persons. To modernize rural industries and increase productivity. Research into technical, social economic problems in selected rural areas. Duration, 18 months, probability of future staff position with research institute. $9000–$12,000, plus 25 per cent overseas pay. Pakistan. S(P)-4820.

Tool Designer, ME, well experienced and able to assume full responsibility for design of compression molds, directing activities of toolmakers and following molded parts to acceptance, for chopped fiber and other types of reinforced plastics. For manufacturer. About $8400. Los Angeles. S(P)-4815.

Designer, Draftsman, ME, young. Experienced in design component and component changes; good on drafting for layout or job details involving structures, mechanical and hydraulic elements of forklift trucks or front loaders. Should be able to handle special order work, new models or redesign existing models. For manufacturer. $6000–7200. Local men only. San Francisco. S(P)-4812.

Product Designer, ME or EE, young. Minimum five years' experience tape-recording or allied field; assume complete design and responsibility for miniature recorders. For manufacturer. $9000 up. San Francisco Pensinsula. S(P)-4807.

Final Production Inspector, mechanical background, well experienced in inspecting; qualified by experience to conduct full and complete operational inspections of electromechanical instruments (recording, actuating, operating) and supervise technicians, for manufacturer. $6500. San Francisco Peninsula. S(P)-4805.

Production-Application Engineer, ME, to 35; minimum five years' machine-shop experience (production and job shop). Should know tooling, costing, estimating, methods, and generally be able to act as first assistant in running small machine-shop operation for manufacturer of pumps. About $7800. San Francisco. S(P)-4800.

Electromechanical Designer, ME. Top notch creative designer for small precision elements in electromechanical consumer device, to develop concepts and ideas into practical manufacturing form. For medium-sized manufacturer. Local and regional men only. $1000 a month. San Francisco Peninsula. S(P)-4796-R.

Senior Mechanical Designer, ME, to 50; minimum six years' experience including supervision in engineering service-type work (engineering, design, layout, draft, specifications) on heavy machinery and equipment (new design and modifications, installation, arrangement) for steel plants, aluminum plants, and heavy metal products. $9600–12,000. San Francisco East Bay. S(P)-4797-R.

Senior Piping Designer, ME, to 50; minimum six years' experience including supervision in engineering service type work on heavy piping, for process plants, stream-power plants, steel plants, or nuclear power experience. $9600–$12,000. San Francisco East Bay S(P)-4793-R.

Chief Engineer, ME, to 45; ten years' experience in design, welding, ASME and API codes, alloys and other metals manufacturing pressure vessels, distills, columns, heat exchangers, for food, beverage, chemical, breweries, some petroleum. Well qualified to carry load of old established medium-sized shop and engineering department. $9000–10,200. San Francisco East Bay. S(P)-4792.

General Engineer, ME, under 50; well qualified by recent and extensive experience in shop and production-job work on medium stamping, forming, piercing operations. Should be well informed regarding production control, industrial engineering, tool and die methods, and general management at an executive vice-president level. For medium-sized shop. Salary commensurate with experience. San Francisco East Bay. S(P)-4790.

OBITUARIES

Hans Aloys Bohuslav (1902–1959), manager, Piston Products, Inc., Park Ridge, Ill., died June 8, 1959. Born, Dresden, Germany, Dec. 14, 1902. Parents, Aloys and Elizabeth (Hintzen) Bohuslav. Education, ME, Charlottenburger Hochschule, 1922. Naturalized U. S. citizen, 1933. Married Wally Selma Reiche, 1928; two children, Gloria Mielke and Bruce Bohuslav. Mem. ASME, 1943. Mr. Bohuslav was a specialist in the field of diesel-engine design, marine and stationary power-plant layout. He held a patent for internal-combustion engines and for a reciprocating valve. He was a member also of SAE and ASM.

Sterling Haight Bunnell (1871–1959), consulting industrial engineer, Stratford, Conn., died Sept. 13, 1959. Born, Stratford, Conn., Jan. 30, 1871. Parents, Rufus William and Catherine (Sterling) Bunnell. Education, PhB, Sheffield Scientific School, Yale Univ., 1891; ME, 1893; Assoc. Mem. ASME, 1894; Mem. ASME, 1903; Fellow ASME, 1938. Married Rebecca Lapham Peterson, 1900. Mr. Bunnell had the rare combination of wide experience in engineering coupled with an understanding of finance and accounting. Before his retirement, Mr. Bunnell had been associated with George S. Armstrong and Co., consulting industrial engineers. As an independent consulting engineer, Mr. Bunnell had traveled extensively in Europe, Asia, and South America. He was the author of two books, "Cost-Keeping for Manufacturing Plants" and "Industrials—Their Securities and Organization"; and he had published over 100 papers in trade journals and the technical press. He had also done many translations of German, French, Russian, and Spanish technical material. He was a member also of The Franklin Institute. Survived by his widow; a son, C. Sterling Bunnell; a daughter, Mrs. Elizabeth Lapham Deery; and three grandchildren and five great-grandchildren.

Albert Marion Chambers, Jr. (1907–1959), chief engineer, Garlock Packing Company, Palmyra, N. Y., died in January, 1959. Born, Buffalo, N. Y., Sept. 28, 1907. Education, AB. Colgate University, 1929; ME, Rensselaer Polytechnic Institute, 1933. Mem. ASME, 1952. Mr. Chambers had been with the packing company since 1942. He held seven patents.

Allen W. Clarke (1886–1957), general mechanical engineer, American Car & Foundry Co., St. Charles, Mo., died Aug. 13, 1957, according to a report recently received by the Society. Born, Jeffersonville, Ind., Jan. 24, 1886. Parents, George R. and Mildred W. Clarke. Education, BS(ME), Purdue University, 1907; ME, 1910. Mem. ASME, 1919. Married Elizabeth L. Howard, 1911. Mr. Clarke had joined American Car & Foundry in 1907 as a draftsman. He held numerous patents in connection with passenger car construction and details.

Claude William Deacon (1926–1959?), professional engineer, firm of Robert L. Brown, Roanoke, Va., died recently according to a notice received by the Society. Born, Covington, Va., March 25, 1926. Education, BS(ME), Virginia Polytechnic Institute, June, 1950. Assoc. Mem. ASME, 1950. Mr. Deacon had previously been employed by the West Virginia Pulp and Paper Co.

Rowland Boyce Drescher (1910–1959), assistant general sales manager, Republic Flow Meters Co., Chicago, Ill., died May 11, 1959. Born, Brooklyn, N. Y., Feb. 19, 1910. Education, ME, Rensselaer Polytechnic Institute, 1932. Mem. ASME, 1945. Mr. Drescher had been with Republic since 1937. He had done design and arrangement of control equipment for various applications including combustion control, pressure reducing, and desuperheating. He had worked also on design of systems to provide and maintain simulated high-altitude atmospheric conditions for aircraft-engine testing.

Robert Martin Fleming (1904–1959), engineer, Coe Manufacturing Co., Painesville, Ohio, died June 25, 1959. Born, Pittsburgh, Pa., Nov. 18, 1904. Education, BS(ME), University of Pittsburgh, 1925. Mem. ASME, 1943. Prior to joining the Coe firm, Mr. Fleming had been with Diamond Alkali Co., Painesville, Ohio.

Elbert Reuben Grant (1936–1959?), draftsman, Sverdrup & Parcel Engineering Co., San Francisco, Calif., died recently according to a notice received by the Society. Born, St. Louis, Mo., March 5, 1936. Education, BS(ME), Purdue Univ., 1958. Assoc. Mem. ASME, 1958.

Randall Doering Griffin (1907–1959), assistant engineer, Allis-Chalmers Manufacturing Co., Milwaukee, Wis., died June 16, 1959. Born, Waterloo, Wis., July 13, 1907. Parents, Frank J. and Irma (Doering) Griffin. Education, BS (ME), Univ. of Michigan, 1938. Married Eva Isabella Lyle, 1933. Assoc. Mem. ASME, 1938. Mr. Griffin had specialized in steam and hydroelectric power plants, substations, and building equipment.

Hector Clinton Griswold (1894–1959), consulting engineer with J. Rich Steers, Inc., New York, N. Y., died Aug. 31, 1959. Born, Salt Lake City, Utah, Jan. 3, 1894. Education, CE, Rensselaer Polytechnic Institute, 1915. Married Janet Wallace. Mem. ASME, 1948. Mr. Griswold served during World War I in the Civil Engineering Corps of the Navy, he remained in the Naval Reserve after the war while practicing as a civil engineer. In 1940, Mr. Griswold was recalled to active duty in the New York Naval Shipyard in Brooklyn. Later he was assigned as West Coast representative of the Army-Navy Petroleum Board. He retired from the Naval Reserve in 1947 with the rank of captain. Mr. Griswold was a former member of the Summit, N. J., Common Council and the Joint Trunk Sewer Commission of Union County. Member also ASCE. Survived by his widow; a daughter, Mrs. A. A. Smith, 2d; a son, Hector W.; and five grandchildren.

Ralph Melvin Hanson (1905–1959), mechanical engineer, Ebasco Services, Inc., New York, N. Y., died Jan. 13, 1959. Born, Montevideo, Minn., Dec. 15, 1905. Parents, Richard and Mathilda Hanson. Education, BS(EE), Univ. of Minnesota, 1931. Married Opal M. Hills; three children, Susan D., Richard A., and Carolyn M. Mem. ASME, 1948. Mr. Hanson joined Ebasco in 1942. He had previously been with Northern States Power Co. since 1925. He was a registered professional engineer in the State of Texas.

James Edward Hunt (1888–1959), administrative engineer, electric operation department, Philadelphia Electric Co., Philadelphia, Pa., died Jan. 1, 1959. Born, Philadelphia, Pa., April 4, 1888. Parents John J. and Ellen Hunt. Education, Drexel Evening School. Married Florence V. Cotton. Assoc. Mem. ASME, 1921; Mem. ASME, 1935. Mr. Hunt had been with the utility since 1906. He was a registered professional engineer in the Commonwealth of Pennsylvania.

Ronald Walter Hunting (1896–1959), design engineer, Philadelphia Electric Co., Philadelphia, Pa., died July 3, 1959. Born, Newport, Vt., June 8, 1896. Education, BS, New Hampshire Univ., 1921. Mem. ASME, 1939. Mr. Hunting had been with the utility since 1921 with the exception of a three year period when he was employed by Atlantic Refining Co. Survived by his widow.

Sidney Preston Johnson (1898–1959?), whose death recently was reported to the Society, had been a consultant, engineering department, Standard Oil Co. of California, San Francisco, Calif. Born, Red Bluff, Calif., March 27, 1898. Education, AB(ME), Stanford Univ., 1921. Mem. ASME, 1949. Mr. Johnson was a specialist in the fields of applied hydraulics, heat transfer, and power. He was a registered civil and mechanical engineer in the State of California.

Christen Rosfjord Kaddeland (1880–1958), consulting engineer, Miehle Printing Press & Manufacturing Co., Hendersonville, N. C., died December, 1958. Born, Mandal, Norway, Aug. 18, 1880. Education, ME, Porsgrund Technical School. 1898. Mem. ASME, 1929. Mr. Kaddeland specialized in the development and improvement of printing presses.

Victor Kappel (1910–1959), president, Connecticut Metal Treating Co., Bridgeport, Conn., died Jan. 23, 1959. Born, Harbin, China, July 8, 1910. Education, BS(ME), Polytechnic College of Engineering, Oakland, Calif., 1934. Mem. ASME, 1955. Mr. Kappel was a specialist in the field of metallurgy. He formed the Connecticut Metal Treating Co. in 1948. He had previously been employed by the Sikorsky and Chance-Vought Division of the United Aircraft Corp. Member also ASM.

Hazael Lafayette Keely (1886–1959), president, Keely Plywood & Millwork, Inc., Pittsburgh, Pa., died July 3, 1959. Born, Ridley Park, Pa., Jan. 16, 1886. Education, ICS and Alexander Hamilton Institute. Affiliate ASME, 1943; Mem. ASME, 1952. Mr. Keely formed his own company in 1939. He was the author of a number of papers on marketing and on management published in the technical press. Mr. Keely was a charter member, past president, and director of the National Plywood Distributors Association, and a member also of FPRS, the American Society of Military Engineers, and the American Material Handling Society.

Chet Arthur Kershaw (1914–1959), consulting engineer, Chet A. Kershaw & Assoc., Portland, Ore., died July 18, 1959. Born, Westhope, N. Dak., Oct. 18, 1914. Education, attended Univ. of Minnesota. Mem. ASME, 1951. He was a specialist on the subjects of viscous flow, combustion, and heat transfer. He was the author of several papers published in the technical press. Mr. Kershaw was a registered professional engineer in the State of Oregon. Survived by his widow, M. Eloise Kershaw.

Frederic Hale Keyes (1871–1959), retired April 1, 1954, administrative assistant, Massachusetts Institute of Technology, Cambridge, Mass., died June 20, 1959. Born, Newtonville, Mass., April 16, 1871. Parents, George Leavitt and Frances A. (Woodman) Keyes. Education, SB, Massachusetts Institute of Technology, 1893. Married Anne Claflin Ellis, 1907 (d. 1954). Mem. ASME, 1902. Survived by a daughter, Nancy Claflin Keyes, Mercer Island, Wash.

Paul Leo Matthews (1926–1959), junior engineer, production department, Hingham, Mass., died April 9, 1959. Born, Arlington, Mass., Nov. 12, 1926. Education, SB(ME), Massachusetts Institute of Technology, 1952. Assoc. Mem. ASME, 1952. He is survived by his widow.

George Michael McKeown (1909–1959), manager, product service department, Vickers, Inc., Detroit, Mich., died March 9, 1959. Born, Hayward, Wis., Sept. 30, 1909. Parents, Edward M. and Honorah M. McKeown. Education, BS(Aero. Eng'g), Univ. of Detroit, 1932. Married Frances M. Wilson, 1938; four children, Shelia M., Michael J., Gary P., and Daniel F. Assoc. Mem. ASME, 1935.

John Gordon Mitchell (1903–1959), staff engineer, Celanese Corp. of America, Charlotte, N. C., died March 5, 1959. Born, Baltimore, Md., Aug. 9, 1903. Parents, Alexander and Elizabeth (Vechio) Mitchell. Education, Baltimore Polytechnic Institute, 1922; attended Univ. of Wisconsin Extension Div. Married Virginia Doughty, 1929; two children, Virginia Gordon and John Gordon Mitchell, Jr. Mem. ASME, 1944. Mr. Mitchell had been with the Celanese Corp. since 1929. Survived by his widow.

Frederick Taft Moses (1885–1959), chairman of the board, Firemen's Mutual Insurance Co., Providence, R. I., died April 6, 1959. Born, Ayer, Mass., Nov. 14, 1885. Parents, Frederick W. and Anna S. (Taft) Moses. Education, BS, Massachusetts Institute of Technology, 1907. Married Lillian M. Flood, 1908; one son, Harlan Taft Moses. Married 2nd, S. Ruth Lawton, 1940. Assoc. Mem. ASME, 1916; Mem. ASME, 1923. Mr. Moses had been president of Firemen's Mutual from 1926–1951. He was named chairman in 1951. He simultaneously held similar offices with Union Mutual Fire Insurance Co. He was president also of Appalachian Insurance Co. and a director of the Providence Industrial National Bank, Protection Mutual Insurance Co., and Textron, Inc.

Willis Dhu Aine Peaslee (1889–1959), president, Valparaiso Technical Institute, and director, Consulting Div., Executive Service Inc., Indianapolis, Ind., died April 2, 1959. Born, Grass Valley, Calif., June 19, 1889. Parents, Willis E. and Maude Mansfield (Chaffee) Peaslee. Education, AB, Leland Stanford Univ., 1909; EE, Oregon State College, 1916; diplome d 'Études Superieurs, Université de Paris, Sorbonne, 1918. Married Ruth Austin McGuinis, 1922. Assoc. Mem. ASME, 1921; Mem. ASME, 1930. Mr. Peaslee was a registered professional engineer in the State of Indiana. He had held executive posts with Jeffrey DeWitt Insulator Co., Belden Manufacturing Co., Underwriters Laboratories, and Bendix Aviation Corp. He held numerous patents, among them were gas turbine and electric telephone circuits for eliminating inductive interference. He was the author of over 30 papers published in scientific journals and the technical press. During World War I he served as a captain in the U. S. Army Engineers Corps and later as an attache of the American Commission to negotiate the peace. Survived by his widow.

William Henry Pugsley (1902–1959), vice-president in charge of research, Hays Corp., Michigan City, Ind., died Aug. 11, 1959. Born, Ashland, Wis., March 20, 1902. Education, ICS, 1927. Mem. ASME, 1940. Mr. Pugsley had been with the Carrick Engineering Co. from 1933, when, in 1937, the firm was taken over by the Hays Corp. He had remained with the Hays firm since that time. He held a patent for combustion-control apparatus. Mr. Pugsley had served the Society as a committee member of the Industrial Regulators Div.

Edward A. Rietmann (1915–1957), president and treasurer, Columbia Machine Products, Inc., Brooklyn, N. Y., died Sept. 30, 1957, according to notice recently received by the Society. Born, New York, N. Y., Nov. 18, 1915. Education, AB, Columbia College, 1942; MSE, Columbia Univ., 1948. Mr. Rietmann served during World War II in the U. S. Navy as a combat officer in the Pacific area. He formed the Columbia Machine Products Co. in 1950. He was a member also of ACS and AMA. Survived by his mother, Ionia M. Rietmann Chatterton, Erie, Pa.

Joseph Harry Newton Roberts (1892–1959), senior engineer, Joseph H. Roberts, Milford, Conn., died April 5, 1959. Born, Naugutuck, Conn., Oct. 30, 1892. Parents, Joseph W. Pfaff and Clara Rebecca (Leas) Roberts. Education, high-school graduate; ICS. Married Edna May Peal, 1922 (div. 1934). Assoc. Mem. ASME, 1922; Mem. ASME, 1927. Mr. Roberts had specialized in the development of special industrial equipment, automatic machinery, product design, patent protection, and the like. He held numerous patents for auxiliary rolling-mill equipment, clutches, and such. He was a registered professional engineer in the State of Connecticut, Massachusetts, and New York. Mr. Roberts served the Society as secretary, treasurer, and chairman of the Executive Committee of the Waterbury Section ASME.

Robert Clinton Seavers, Jr., (1922–1959), contract engineer, Miller Hofft, Inc., Richmond, Va., died April 9, 1959. Born, Pottstown, Pa., March 11, 1922. Education, BS(ME), Virginia Polytechnic Institute, 1950. Assoc. Mem. ASME, 1959. Mr. Seavers had previously been employed by American Oil Co., Blacksburg, Va.

Frank Shakun (1895–1959), president, Grayarc Co., Brooklyn, New York, died July 17, 1959. Born, Russia, March 15, 1895. Education, BS., Cooper Union, 1922. Assoc. Mem. ASME, 1922; Mem. ASME, 1940.

Albert K. Smith (1894–1959), retired, had been with Idaho Beryllium & Mica Corp., died Aug. 26, 1959, in St. Petersburg, Fla. Born, New York, N. Y., Dec. 25, 1894. Education, BS-(ME), Cooper Union, 1920; ME, 1923. Jun. ASME, 1917; Assoc-Mem. ASME, 1923; Mem. ASME, 1927. Mr. Smith had been a registered professional engineer in the State of New York. Survived by his widow, Ann Smith.

Cleveland Conner Soper (1885–1959), retired, died July 22, 1959, in Panama, R. P. Born, New Haven, Conn., Feb. 23, 1885. Education, BS(EE), Tufts College, 1910. Mem. ASME, 1945. Mr. Soper had been with Ferry Machine Co., Kent, Ohio, from 1939 to the time of his retirement. He was a member also of American Society of Metals and Society of Automotive Engineers. Licensed engineer in the State of

Ohio. Survived by a son, Cleveland Conner Soper, Jr., Panama, R. P.

William Staniar (1883–1959), editor-in-chief, "Plant Engineering Handbook," McGraw-Hill Publishing Co., New York, N. Y., died Sept. 15, 1959. Born, Newark, N. J., Oct. 12, 1883. Parents, Walter and Florence M. Staniar. Education, Hon. ME, Univ. Of Delaware, 1940. Married Ethel Ball, 1911 (div.); married 2nd, Emily D. Leech, 1935. Mr. Staniar was an authority on power engineering and, prior to his retirement, had been a design engineer and special draftsman for E. I. du Pont de Nemours and Co. He had compiled and published several works on engineering and was the author of the mechanical-power section of the Encyclopedia Britannica, 14th edition. He was a member of Tau Beta Pi. Survived by his widow; and a daughter, Mrs. E. W. Wildrick, Jacksonville, Fla. Mem. ASME, 1914.

Edgar Harvey Stryker (1920–1959), industrial engineer, United Air Lines, San Francisco, Calif., died Aug. 18, 1959, in the Montana earthquake. Born, Rochester, N. Y., July 22, 1920. Education, BS(ME), Univ. of California, 1942. Assoc. Mem. ASME, 1942; Mem. ASME, 1953. Mr. Stryker had formerly been with Shell Chemical Corp. and with Pabco Products, Inc. He was a registered professional engineer in the State of California. Member also of TAPPI and NSPE, and of Tau Beta Pi.

Basil Joseph Terrell (1916–1959?), chief design engineer, The Parsons Marine Engineering Turbine Research and Development Assoc., Pametrada Research Station, Wallsend, Northumberland, England, died earlier this year according to a notice received by the Society. Born, London, England, Sept. 6, 1916. Education, BSE, Rugby College of Technology and Arts, 1938. Mr. Terrell joined Pametrada in 1946. He was the author of a number of published papers on the subject of turbomachinery. He held over 25 patents. Mr. Terrell served in World War II as an officer with the Royal Engineers. Mem. ASME, 1957.

Rowland Tompkins (1881–1959), chairman of the board and chief executive officer, Rowland Tompkins & Son, Inc., Hawthorne, N. Y., died July 29, 1959. Born, Westfield, N. J., Dec. 15, 1881. Education, attended Cooper Union. Mem. ASME, 1938. The firm which bears Mr. Tompkins name was formed in 1937 and has been responsible for the installation of industrial piping in a number of large plants. He served during World War I in the U. S. Army, AEF. Survived by a son, Howard Tompkins.

Bertram Orlando Vannort (1900–1959), president, B. O. Vannort Engineers, Inc., Charlotte, N. C., died June 27, 1959. Born, Port Deposit, Md., July 2, 1900. Education, BS, Univ. of Michigan, 1928. Mem. ASME, 1949. Mr. Vannort had been in private consulting practice since 1938. He specialized in design, preparation of plans and specifications, and supervision of construction of electric distribution and transmission lines, generating stations, and substations. He was a registered professional engineer in eight states.

Charles Jacob Wyler (1896–1959?), whose death recently was reported to the Society, had been retired. He was formerly with A. M. Lockett & Co., Ltd., New Orleans, La. Born, New Orleans, La., Jan. 30, 1896. Parents, Julius and Margaret (Glese) Wyler. Education, BE, Tulane Univ., 1917. Assoc. Mem. ASME, 1921; Mem. ASME, 1931. Mr. Wyler served as a lieutenant in the Coast Artillery during World War I. He joined the firm of contracting mechanical engineers in 1919. At the time of his retirement he was executive assistant to the vice-president in charge of engineering.

General of the Army George Catlett Marshall—1880–1959

GENERAL OF THE ARMY GEORGE CATLETT MARSHALL, Chief of Staff of the U. S. Army in World War II, Secretary of State, Secretary of Defense, special envoy to China, and architect of the European Recovery Program, died October 16, 1959.

For his distinguished services in military science and for his accomplishments as a public servant, General Marshall was made an Honorary Member of the Society in 1947. This honor was one among many for General Marshall who had in his lifetime received 13 honorary degrees; the Distinguished Service Medal, Silver Star, and Victory Medal with five bars of the United States; and countless honorary awards from Chile, Cuba, Ecuador, France, Great Britain, Italy, Montenegro, Morocco, Panama, Peru, and Russia. He was awarded the Theodore Roosevelt Distinguished Service Medal of Honor for 1945. In 1953, in recognition of his role in framing the European Recovery Plan—the Marshall Plan—he was named the recipient of the Nobel Peace Prize. While hospitalized prior to his death, he received one more honor—the Charlemagne Prize for 1959, for helping the cause of European unity through the Marshall Plan.

Born at Uniontown, Pa., on December 31, 1880, General Marshall was the son of George Catlett and Laura (Bradford) Marshall. He received his early military training at Virginia Military Institute; was an honor graduate of the U. S. Infantry-Cavalry School, and a graduate of the Army Staff College.

General Marshall was a staff officer during most of his career. While he was not lacking in the ability to command men, early in his career his superiors found him extremely useful as a staff officer mainly in operations planning. He had quick insight into a tactical problem, an inborn sense of military supply and operations, and an almost uncanny memory.

During World War I George Marshall was advanced from the rank of captain to colonel. There followed a series of disappointments and frustrations, but in 1936 Colonel Marshall became a brigadier general. From then on his rise was rapid. He became Deputy Chief of Staff in 1938, Chief of Staff in 1939, and as such was one of the principals in defining the strategy that won victory in World War II.

His war duties concluded with the surrender of Germany in 1945; General Marshall was summoned by President Truman to stave off the threatened Nationalist-Communist civil war in China, a mission which after two years of his efforts was unsuccessful.

In 1947, General Marshall became Secretary of State. It was in this capacity, in a speech at Harvard University, that he outlined the plan since known as the Marshall Plan, to implement the postwar recovery of Western Europe.

Recently, speaking in the House of Commons, Philip J. Noel-Baker, 1959 Nobel Peace Prize Winner, said of the plan that it was possibly the greatest "act of such national generosity." He was speaking in support of a Government bill to double to 24 the number of Marshall scholarships offered each year for study by Americans at British universities. The scholarships are in gratitude for Marshall Plan aid.

George Catlett Marshall

Taxed by the arduous years as Chief of Staff, the strain of his effort in China, and the burden of the post, General Marshall resigned as Secretary of State at the end of a year.

After 20 months of rest, he was again appointed to the Truman cabinet as Secretary of Defense in 1950. Almost a year later he resigned this post to retire to his Leesburg estate.

As a statesman, General of the Army Marshall will be remembered primarily for the Marshall Plan, but his business-like reorganization of the State Department, his continued selection of good men to be his principal lieutenants, and his contributions to unification in the Department of Defense and to mobilization for the Korean War are also monuments to his achievement.

In his statement upon the death of General of the Army George C. Marhsall, President Eisenhower summarized our nation's debt to one of our "most illustrious sons." That statement read in part: "His courage, fortitude and vision, his selflessness and stern standards of conduct and character were an inspiration, not only within the Army, but throughout the nation and among our allies. For his unswerving devotion to the safeguarding of the security and freedom of our nation, for his wise counsel and action, and driving determination in time of danger, we are lastingly in his debt."

He is survived by his second wife, the former Katherine Tupper Brown. His first wife, Elizabeth Carter Coles Marshall, died in 1927. He remarried in 1930.

You get these benefits when you install YARWAY GUN-PAKT EXPANSION JOINTS

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

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  Positive alignment of sleeve in stuffing box *—where it counts!*
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  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

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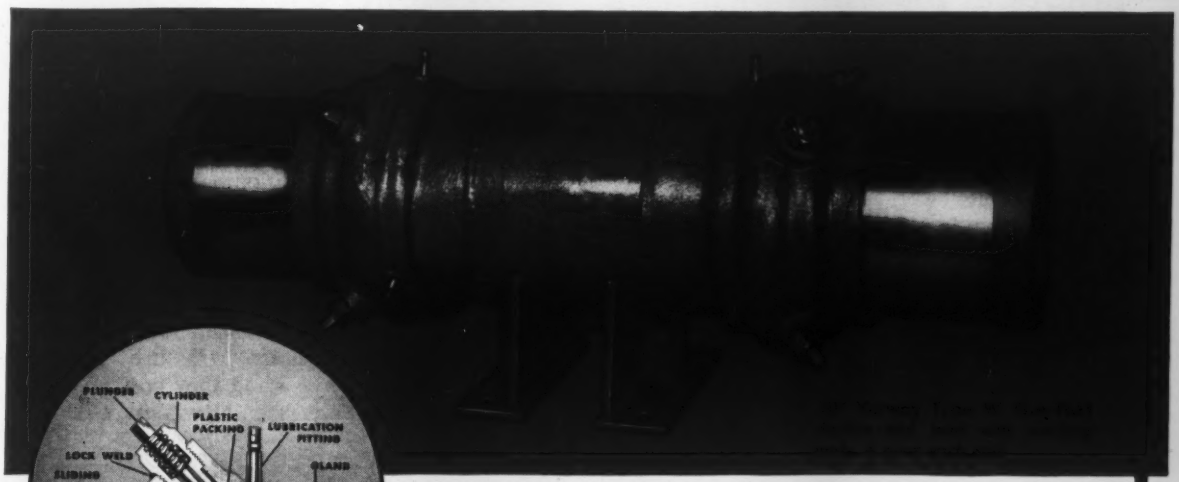
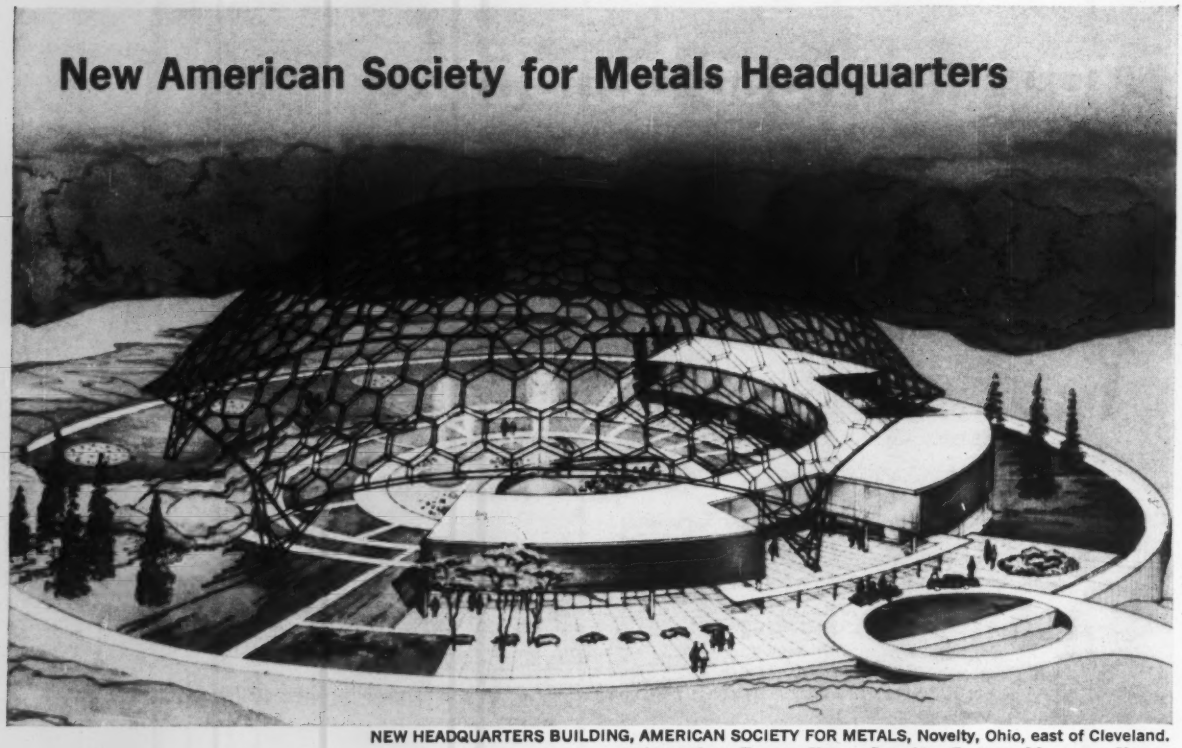


Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

YARWAY GUN-PAKT

New American Society for Metals Headquarters



NEW HEADQUARTERS BUILDING, AMERICAN SOCIETY FOR METALS, Novelty, Ohio, east of Cleveland.
Architect: JOHN TERENCE KELLY. *Consulting Engineer:* MAYER AND VALENTINE. *General Contractor:* GILLMORE-OLSON COMPANY. *Plumbing and Heating Contractor:* SPOHN HEATING & VENTILATING COMPANY. *Dome Design:* R. BUCKMINSTER FULLER, SYNERGETICS, INC.

Imagination shows in the building — practical planning in the choice of Jenkins Valves

Metals Park . . . dramatic new Headquarters of the American Society for Metals, is a showcase for the wonderful world of metals.

The geodesic dome, "world's largest space lattice," required thirteen miles of tubing and rods in openwork trellis. It stands as a monument to man's imagination in the use of the raw elements of the earth, as symbolized in the circular Mineral Garden below. At Metals Park, metals are everywhere and everything — providing an ideal background for ASM's many services to 30,000 members in the metal industry.

You would expect men of metals to choose metal products of superiority for their headquarters. And they did — including Jenkins Valves for *all* plumbing, heating and air conditioning lines. They had good reason: superior metals give Jenkins Valves the extra stamina that makes them famous for long life and dependability.

Whenever a building is planned with the *future* in mind, it's wise to specify or install Jenkins Valves. They're the *practical* choice to assure longtime efficiency and economy — and they cost no more. Jenkins Bros., 100 Park Ave., New York 17.

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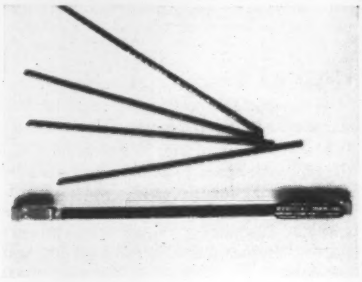
NEW EQUIPMENT



Drawing Leads

Two Microtomic drawing leads No. 6100-2 for use in a mechanical holder are packed in a clear transparent plastic tube by Eberhard Faber Pencil Co.

Both ends are closed with an adjustable clasp containing a pink pearl eraser, the standard quality eraser in drafting rooms.

The leads contained in the plastic tube packing are available in eight degrees. The unit is packaged 72 tubes in a set-up box with a cover wrap. —K–1

Vibration System Tests

A new method of testing gaseous oxygen valves under actual operating conditions has been announced by Whittaker Engrg. Laboratories, Telecomputing Corp.

The labs are now testing USAF BMO GOX valves and high performance units for the X-15. The new technique consists of providing complete environmental flight conditions to an operating valve.

The firm says a major problem has been exposing the test specimen to the dynamic forces of sinusoidal vibration while it is actually undergoing functional testing. This has been solved by a special testing arrangement which permits attaching the valve to an electrodynamic shaker while it is connected to an ullage chamber at the GOX facility. The sinusoidal vibration is applied by a Ling Electronics vibration power generator, Model PP40/40, which provides up to 5000 force pounds over a frequency range of 5 to 5000 cps. Testing under vibrational conditions provides data on mounting and structural integrity as well as on the basic valve action. —K–2

Limit Switch

Rotary cam limit switches with from 2 to 16 individual circuits are now available from Eagle Signal Co.

The units are engineered to operate for millions of operations at speeds up to 300 rpm with no observable wear. Components contributing to the heavy duty construction of these limit switches include $^3/_8$ in. coin silver nonflexible contacts rated conservatively at 15 amp, ball bearing supported cam shaft, nylon roller cam followers, 2-in. diam nickel plated cams assure accuracies to $^1/_2$ per cent.

The $^1/_4$-in. cam shaft extends beyond the bearing mounting for connection to an external drive. —K–3

Weighing System

Weber Air-Weigh Co. announces a system for weighing the contents of bins, tanks, truck tanks, conveyor loads or anything else that can be weighed on platform scales.

The unit is available for loads covering the entire range from 0–300 to 0–200,000 lb.

The system is operated by a small load-cell placed under each leg of a tank, bin, conveyor section, platform. Linear pneumatic pressure is automatically controlled in each load-cell and produces a pneumatic signal on a meter, which may be remotely located, the firm reports. —K–4

Electrical Duct

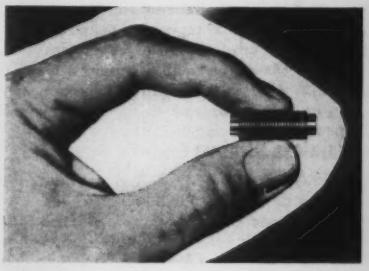
A new system for distributing electricity in industrial plants and commercial buildings has been introduced by BullDog Electric Products Div., of I-T E Circuit Breaker Co.

Called XL duct, the product is described by the company as being exceptionally flexible, easy to install, and it features plug-in power take-offs at any place along the line without disconnecting the main power line.

According to the company, the duct is capable of withstanding unusual electrical and mechanical stresses which might otherwise destroy it, based on present and future available short circuit values. It is also claimed to incorporate the lowest possible voltage drop practicable.

The duct is specifically designed to use aluminum properly, but copper is available if desired. Its design incorporates a simplified joint with a minimum number of bolts and its casing meets present building structural standards.

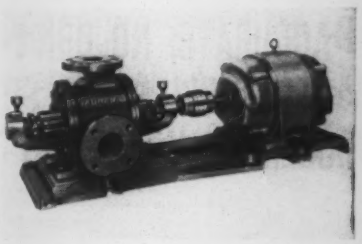
"The new duct will be available in ampere ratings of 225 through 1000, voltage ratings through 600 volts a-c 1 ϕ—3 ϕ—4W, and full neutral available in all sizes. —K–5



Miniaturized Bellows

Flexonics Corp. now has available new miniaturized bellows with a nominal id of $^5/_{32}$ in.

The units are seamless, hydraulically formed, precision bellows in a wide range of metals and performance characteristics. The firms says they have exceptional strength and extreme sensitivity to temperature and pressure changes, as a result of their light wall thickness. —K–6



Turbine Type Pumps

New design changes on its Apco two-stage turbine type pumps have been announced by the Aurora Pump Div., New York Air Brake Co.

The firm says the major new feature is a revised shell housing design which directs the fluid from the first to the second stage impeller in a 180 deg cross-over. By thus placing in opposition the resultant forces of first and second stages, the forces are equalized and a condition of balanced radial loads is achieved, the company explains. At the same time the arrangement eliminates shaft deflection.

Removable channel rings provide for replacement of eroded or corroded surfaces. Wear is said to be reduced by absence of metal to metal contact within the pump channel. —K–7

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Midget Solenoid

Guardian Electric Mfg. Co. has developed a new (No. 28) midget solenoid, available a-c or d-c, intermittent or continuous duty.

The solenoid has tapered plug and plunger. Plunger strokes from $^1/_{16}$ to $^1/_2$ in. with a lift of over 41 oz. Over all dimensions are $1^1/_8 \times 1 \times 1^3/_{16}$ in. Weight is approximately $3^1/_2$ oz. **—K–8**

Stainless Strainer

Spraying Systems Co. has introduced a strainer designed for high pressure lines.

It is made entirely of stainless steel, and has a strainer screen assembly designed to provide a large area for dependable fluid flow and minimum maintenance at high pressures up to 4000 psi.

Strainer inlet and outlet are at the top, so that the strainer may be cleaned when necessary without removal from the line. The strainer is cleaned either by removing the bottom pipe plug and flushing, or by removing the strainer lower body, which releases the entire screen assembly.

Lower body of the strainer has two milled flats for wrench grip. **—K–9**

Servomotors

Kearfott Co. has introduced Size 18 servomotors to meet the high performance, severe temperature requirements of missiles and high speed aircraft.

The high temperature V112–32, 422012–1, and 422013–1 Size 18 motors are said to be constructed of advanced temperature resistant parts and impregnating materials. According to the firm, the V112–32 operates effectively at temperatures ranging from −54 to +200 C and the 422012–1 and 422–013–1 motors operate effectively at temperatures ranging from −54 to +175 C. **—K–10**

Vacuum Blowers

Ten sizes of small-volume vacuum blowers comprise a new line being offered by Roots-Connersville Div. of Dresser Industries, Inc.

Designed for capacities from 30 to 1000 cfm and vacuum to 20 in. Hg in single stage application, the units may be compounded for vacuum service over 20 in. Hg.

Major features of the design as listed by the manufacturer include elimination of internal valves, absence of contact between moving parts. **—K–11**

Sheet Retrieving Device

A fork truck attachment which retrieves the load-carrying sheets used in pallet-less handling, said to be the first device of its kind, has been introduced by the Industrial Truck Div., Clark Equipment Co.

The unit is named Model 5000 sheet retrieving Pul-Pac. It retrieves the sheet by either pulling the sheet from under its load or pushing the load off the sheet. This action is accomplished by a design which permits the gripper jaw and pusher rack to act simultaneously or independently of each other. **—K–12**

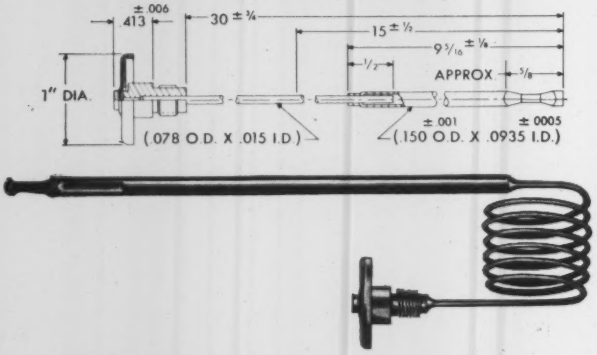
Flagging Tape

A versatile plastic flagging tape has been introduced by Keuffel & Esser Co.

Made of vinyl plastic in five vivid colors, the tape is designed to act as a high-visibility marker for identification purposes. Its uses include locating boundary lines, stakes, stations, landmarks, center lines, property lines. Weather and wind-resistant tape tears clean, takes pencil and ball point pen markings and remains supple at temperatures as low as −30F. **—K–13**

TEMPERATURE SENSOR

ACCURATE, NO-DRIFT CONTROL FOR APPLIANCES SOLVED BY ROBERTSHAW DIASTAT® ASSEMBLY



Temperature sensing elements like this one for a range oven control offer permanent accuracy with no drift, consistent calibration, no resetting, long life and savings in space, weight and unit cost. Ambient temperature sensing devices are unnecessary in most applications. Typical stroke is .035" for a 1" diameter stainless steel diaphragm. Ideal for sensing temperatures up to 650°F. All units are custom engineered and delivered as pre-assembled "packages," tested and ready for mounting. **WRITE FOR BULLETIN D6012!**

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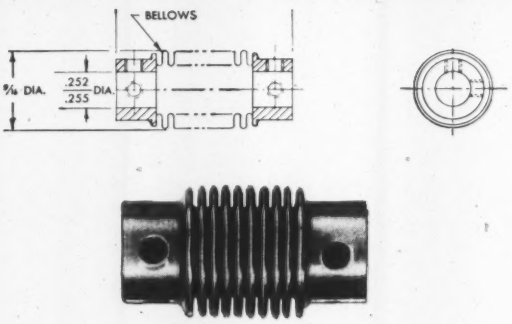


Servomechanisms, instruments and similar drive and control systems are the big users of these small, flexible units. Ideal for guarding against misalignment friction and bearing wear problems. Save space and weight. Cut down noise. Simplified design utilizes seamless metallic bellows, in choice of several metals, connected to two hubs. Sizes from $^{15}/_{32}$" O.D. Stock sizes accommodate shafts from ⅛" to ½". Other sizes custom-engineered. **WRITE FOR DATA SHEET D8012!**

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Miniaturized Fan

Electro Products Div., Western Gear Corp., announces the design and manufacture of a miniaturized fan designed specifically for electronic or avionic application.

Powered by a 28-v d-c motor, the fan produces 45 cfm of air at 17,000 rpm. The unit measures less than 2-in. in diameter and 2-in. in length and is identified as Model F2-17. **—K–14**

Gage Pressure Switch

Haydon Switch, Inc., announces its 1590 series pressure switch, latest development in its new line of pressure switches.

The unit weighs only $2^1/_2$ oz, max, is 3 in. long, and .937 in. diam. Ambient temperature range is −65 to 300 F. Pressure range is 10 psi to 4000 psi. Versions of this switch, capable of sensing absolute pressures, are also available.

The switch is factory-set to actuate at any desired pressure level within the broad range of 0.5 psi up to 4000 psi. All moving parts are environmentally sealed in a rugged aluminum and steel housing. **—K–15**

Pneumatic Transmitters

Simplex Valve and Meter Co. announces the addition of a group of pneumatic transmitters to its line of products for the water, sewage, and industrial wastes fields. These transmitters work on a 3–15 psi signal and are accurate over a wide range of flows.

The PN unit is designed for rate of flow and the TD unit for loss of head.

The PN transmitter produces a linear signal without the necessity of supplementary pneumatic relays and offers point accuracy over wide ranges of flows with minimum differential. The transmitter produces a standard 3 to 15 psi signal while consuming less than .1 cfm of air.

The Type TD is an instrument of the force-balance principle. The unit is small, rugged, self draining, and venting and has a calibrated accuracy within ±1 per cent over the range of 0–144 in. of water. Its construction has eliminated stuffing boxes, levers, pivots, or relay valves and is provided with an external zero adjustment. **—K–16**

Use a CLASSIFIED ADVERTISEMENT
For QUICK RESULTS

Motorized Speed Reducer

Double capacity from light drill press and lathe equipment is claimed for a new machine attachment announced by Tool-Rite Engineering Co.

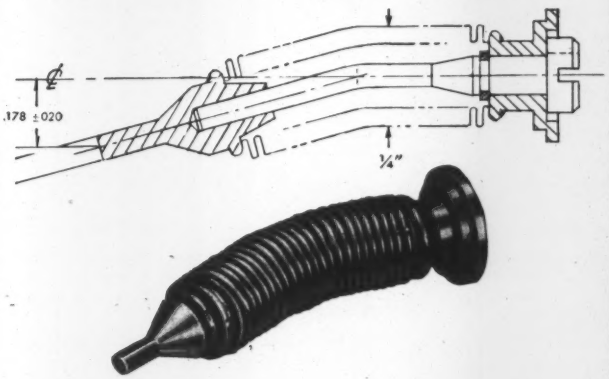
The unit is a motorized, quick-change machine speed reducer, named Pull-Gear. In addition to increased capacity from the greater number of machine speeds with the speed reducer, the unit also provides instant changing to turning speeds slow enough for reaming, tapping, boring, and similar operations on these light-duty machines.

The new unit, developed by Pull-Gear Co., is designed to bolt directly to standard machine mounting plates. Changing from a high to a low turning speed is accomplished by shifting a lever. Where hand shifting is impractical as in lathe operations, a simple lever mechanism attached to the machine frame provides for quick mechanical shifting to required speeds. A simple, solenoid coil hook-up can be also installed for remote control speed shifting.

Band saws, milling machines, boring mills, shapers, and similar light-duty machine tools can be powered by the unit. **—K–17**

MINIATURE BELLOWS

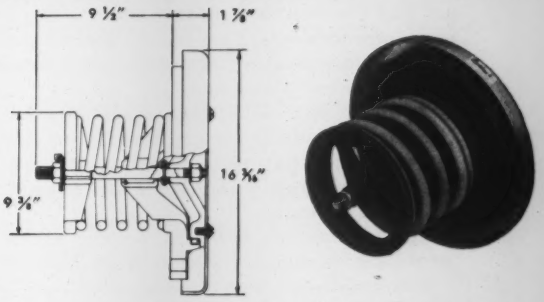
SAVE SPACE AND WEIGHT WITH RUGGED, MINIATURE ROBERTSHAW METALLIC BELLOWS



Seamless metallic bellows only ¼" and 5/16" O.D. permit further miniaturization in aircraft, missiles, instruments and other equipment. Available in a wide range of bellows metals to provide the desired strength and performance characteristics. Sensitive to temperature and pressure changes. Custom-engineered . . . but available in any quantity you need. Proved in dozens of miniaturized assemblies. WRITE FOR BULLETIN D1012!

PRESSURE RELIEF VALVE

VENTS PRESSURE BUILD-UP IN TRANSFORMERS, TANKS . . . RESEALS AUTOMATICALLY WITH NO RESETTING!



Now you can forget breakaway seals that have to be replaced each time dangerous high pressure build-ups are relieved. Robertshaw Pressure Relief Valve operates instantaneously. No moisture or contaminants can enter vessel during blow-off or automatic resealing and resetting. No periodic inspections necessary.
WRITE FOR ENGINEERING DATA SHEET D9012!

Robertshaw CONTROLS

BRIDGEPORT
THERMOSTAT DIVISION
Milford, Conn.

You'll find them better for pressure if they're

SHENANGO CENTRIFUGAL CASTINGS

WHATEVER the inside or outside pressures, Shenango centrifugal castings are better able to withstand them without failure.

Parts cast by the Shenango centrifugal process are much tougher because their finer, *pressure-dense* grain avoids stress concentrations while providing greater strength, better elongation and freedom from such costly defects as sand inclusions, blowholes and such.

Whether you need rings, rolls, sleeves, liners, bushings, bearings, mandrels or *any* annular or symmetrical part . . . ferrous or non-ferrous . . . in whatever shape, size or dimension to meet your requirements . . . Shenango can do the job. And do the job *better!*

For informative bulletins on the answers to your tough problems, it will pay you to write now to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, O.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

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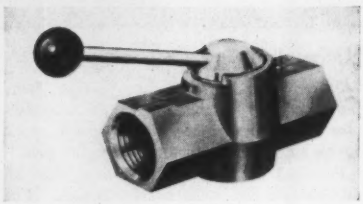
LATEST CATALOGS



Brass Plug Valve

The 9200 series brass plug valve, for pressures ranging from a full vacuum to 150 psi, and incorporating O-rings to affect a dead tight seal, is now available from Circle Seal Products Co.

The plug valve can be used with virtually all non-corrosive liquids or gases and is available in 1/8, 1/4, 1/2, and 3/4 in. female pipe sizes, the company reports.

The valve has a straight cylindrical plug using O-rings for sealing. Two of the rings are installed in machined grooves near each end of the plug and provide a dead tight seal when the valve is open.

A third ring is installed in a lipped groove in the face of the plug 90 deg from the plug flow passage. When the valve is closed by a quarter turn, the O-ring moves into position around the inlet port to provide a dead tight flow seal. **—K–18**

Horizontal Shaft Pumps

A new AW series of self-priming centrifugal pumps introduced by Nagle Pumps, Inc. features a trap with a readily accessible and removable strainer.

The firm states that the trap holds the prime; suction entrance is at top of the trap, and the separator below the discharge opening is an integral part of the casing.

Three types of bearing stands are available, depending upon the conditions involved. One complete unit—stand and water-end; a heavier duty unit in which much of the shaft is enclosed within the bearing stand, and the third type with the lightest of the three bearing stands.

All pumps in the series have capacities up to 1000 gpm with heads up to 125 ft. Sizes range from 1 to 5 in. Because of the self-priming feature these pumps can be stationed above the liquid level. Water-end parts are made of a variety of corrosion resistant metals, depending upon the severity of the corrosion. **—K–19**

Socket Screws

Miniature button-head socket screws are now being offered by Bristol Co. as stock items in its Dyna-Mite line.

They are available with either standard hex or spline sockets in alloy or stainless steel. Recommended for resistance to shock and vibration, the button-head socket screws are available in sizes No. 0 through No. 3. **—K–20**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
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Silicon Rectifiers

Introduction of two new lines of 250-v d-c silicon rectifiers, one for heavy-duty steel mill and industrial applications, and the other for general purpose operations has been announced by Allis-Chalmers.

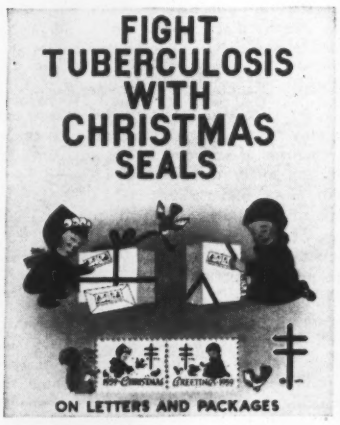
The heavy-duty rectifiers are available in 400, 500, 600, 750, 1000, 1500, and 2000-kw ratings with standard sizes carrying 100 per cent continuous loads, 125 per cent current loads for two hours, or 200 per cent for 1 minute.

The new 150 to 300-kw general purpose rectifiers are designed for crane, hoist and general shop service, elevator supply, machine tools with d-c motors or control, magnetic chucks and lifting magnets, etc. The single factory-packaged units are available in ratings of 150, 200, 250, and 300 kw and for three-phase, 60-cycle primary voltages of 208, 240, 480, or 600.

The heavy-duty silicon rectifier consists of incoming line, transformer, rectifier, and d-c breaker sections assembled on three related bases for ready installation. The transformers are self-cooled dry type.

The firm says use of high quality silicon diodes and high speed current limiting fuses in series with each paralleled branch in the rectifier unit insures immediate isolation of a faulted cell without interruption of the d-c power output.

Fuse monitoring equipment flashes a warning upon failure of the first diode and helps locate the faulted cell. Since the remaining paralleled cells in the phase have sufficient capacity to carry normal loads without harm, the faulted diode can be replaced at the convenience of the operator. A second failure is a signal to the fuse monitoring system to shut down. Use of special high speed current limiting fuses when removing a faulted cell from the circuit makes possible such a rapid clearance that power to the load is unaffected. —K-21



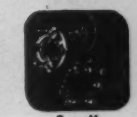
ROCKFORD

TROUBLE FREE THROUGH GENUINE DESIGN

Trouble Free usage and Genuine Design can be obtained for your products when the designing engineer specifies a ROCKFORD CLUTCH. A vast backlog of knowledge and experience is available to him at anytime. The American industry has learned that ROCKFORD CLUTCHES mean extra values. The strength and toughness—the completeness of a Genuine Design—the wide range of sizes—the excellent machining—the long range economies received—all these advantages, and more, of ROCKFORD CLUTCHES combine to create an unexcelled reputation for versatility. Let our engineering staff help you to determine the type and size clutch best suited to help improve the power transmission control in your next model.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.


Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

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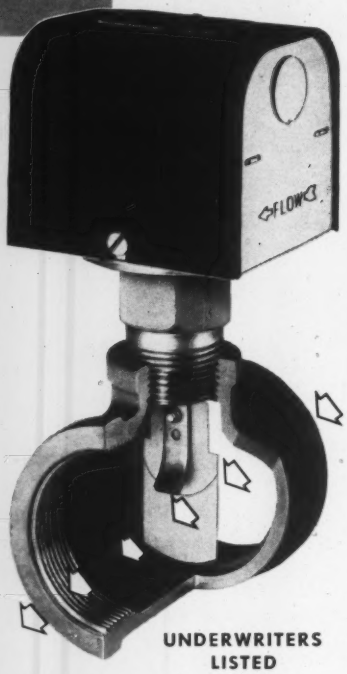
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

CLUTCHES

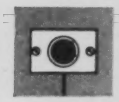
McDONNELL *Flow Switches*

FS4 Series Flow Switch shown mounted in a 2 inch Tee

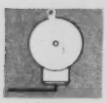


Here's what they do!

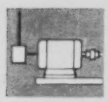
What you see here is a compact, well-built switch that makes or breaks a circuit (as required) when liquid flows or stops flowing. It's an economical and positive way to start or stop anything electrically operated. Just to highlight a few uses:



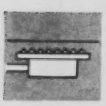
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.



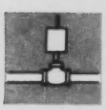
to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops.



to start or stop automatic burners—start a booster heater when water draw occurs, stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

UNDERWRITERS LISTED

Positive snap action switch. Easy to install and wire. Segmented paddle fits any pipe from 1″ through 3″. Unit shown handles pressures to 100 psi, temperatures to 300° F., in these types:

FS4-3—SPDT switch. Opens and closes two separate circuits with flow; closes and opens same two circuits with no flow.

FS4—Closes with flow; opens with no flow.

FS4R—Opens with flow; closes with no flow.

NOTE: Model E-2 available for larger pipes, pressures to 150 psi.

McDONNELL & MILLER, *Inc.*
3510 N. Spaulding Ave., Chicago 18, Ill.

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Coupon brings bulletin

—covering design, construction, electrical ratings, dimensions, typical applications.

Please send me a copy of Flow Switch Bulletin FS1-A.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Pipe Joint Compound

Plastic lead seal industrial pipe joint and thread sealing compound, is now available in miniature tubes especially designed for original equipment manufacturers' installation and conversion kits.

The manufacturer, Crane Packing Co., says other kit uses such as replacement, maintenance, repair and the do-it-yourself types are also recommended.

The tubes contain 1 oz of compound which is sufficient to handle normal kit needs. The firm says they are compact and pliable so that they can easily be fitted into "tight" spots. Tough vinyl plastic construction and a screwed cap give maximum protection against breakage or leakage and also contribute to neat and easy dispensing of the compound.

The compound is used in refrigerant, chemical, petroleum, LP and natural gas, water, steam and many other comparable services. It is designed to prevent seizing and galling and lasts for the life of the connection—yet allows easy disassembly because it remains permanently plastic. Temperature range is to 550 F, pressures to 6000 psi. **—K-22**

Drilling Machine

A fully automated, six-station special in-line transfer machine that drills and probes holes in truck engine rocker arm shafts at a rate of 211 parts per hour at 100 per cent efficiency is announced by Snyder Corp.

The rocker arm shafts are fed to a transfer way from a hopper feed and escapement mechanism at one end of the machine. A rotating finger transfer bar actuated by a hydraulic cylinder at the end of the transfer way advances the SAE 1010 tubular 17-in. long, $^3/_4$-in. od rocker arm shafts from station-to-station for the various drilling and probing operations.

Individual parts are lifted a small amount by spring-loaded centering fingers that enter each end during the transfer operations between stations. Clamping fixtures at each station locate the parts for the machining and checking operations. **—K-23**

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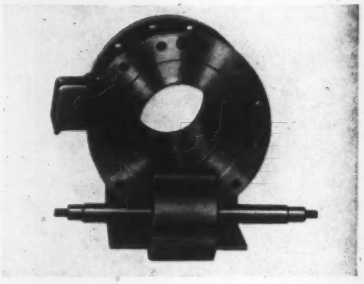


Canned Motor

Peerless Electric Div., H. K. Porter, Inc. has introduced stainless steel canned pump motor for handling nuclear contaminated, highly corrosive or highly volatile liquids.

It is being produced in sizes from $^1/_2$ to 5 hp. Dimensions follow those of NEMA specifications for the next higher horsepower at the same motor speed.

Bearing type and material depends on the liquid being pumped, the temperature of the liquid and its chemical composition, the company explains. Stainless ball bearings, carbon block, glass, teflon, cintered bronze, teflon impregnated bronze and other materials are available for bearing use.

Stainless steel liners and covers are all welded to form a perfect seal over each welded surface. End brackets are attached with O-ring seals. Stators are completely sealed.

Typical characteristics on a $^3/_4$-hp motor are: frame 182; rated speed 1100 rpm; voltage 220, 3-phase; efficiency at full load 60 per cent; actual speed at full load 1110 rpm; locked rotor torque 180 per cent at full load; maximum breakdown 250 per cent of full load torque. **—K–24**

Leak Detection

General Vacuum Corp. announces its new 'Series 800' line of high production leak detection systems.

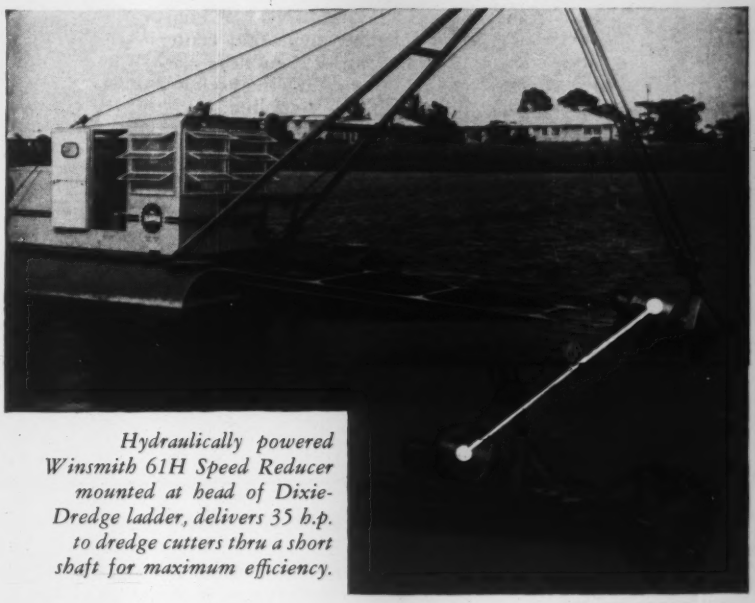
Designed specifically for in-line operation and high production rates, the systems are either fully or semi automatic eliminating or minimizing operator error. The firm says results are quantitative so that changes in quality may be detected, recorded, and action taken prior to rejection on a "go-no/go" basis.

Results are reproduceable since the process takes place in a controlled vacuum and is not affected by stray gases or other variables in the atmosphere.

The company states that the systems are suited for the production testing of all types of vacuum, pressurized, and hermetically sealed products such as aerosols, gas cylinders, refrigeration and air conditioning systems, radiators, missile and aircraft components, electronic assemblies, and fire extinguishers. **—K–25**

Winsmith speed reducers used by Dixie-Dredge

in "one of the toughest jobs ever applied!"



Hydraulically powered Winsmith 61H Speed Reducer mounted at head of Dixie-Dredge ladder, delivers 35 h.p. to dredge cutters thru a short shaft for maximum efficiency.

"Winsmith Speed Reducers driving Dixie-Dredge cutters have a high shock load application and probably perform one of the toughest jobs ever applied," reports John H. Milne, president of Service Machinery Corp., North Miami, Florida, makers of this highly efficient, self-contained mobile dredging unit.

"Winsmith Reducers offer us a high torque output in a small package," says Mr. Milne. *"It operates at all angles from vertical to horizontal and has been very satisfactory in use."*

If you want satisfaction such as Service Machinery and leaders in every other industry are enjoying, check these Winsmith advantages: (1) most complete selection for every output requirement from 1/100 h.p. to 85 h.p. in ratios from 1.1:1 through 50,000:1, (2) shaft and mounting arrangements to fit your installation, (3) maximum torque designed into minimum space, (4) sound engineering and craftsmanship backed by over fifty years in the business. Write today for Catalogs 155 and SM-57. Select the "custom" reducer for your job from Winsmith Standard stock!

WINSMITH SPEED REDUCERS

WINSMITH, INC.
20 Eaton Street, Springville, (Erie County), N. Y.

Mechanical Engineers

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THE ENGINEERING INDEX
29 W. 39th Street, New York 18, N. Y.

VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

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29 W. 39th St. New York, 18.

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Electric Hydraulic Presses

Two new motorized hydraulic presses, engineered to handle jobs requiring pressures of 60 and 80 tons respectively, have been introduced by the ACCO Equipment Div., American Chain & Cable Co.

Frame members of the high capacity presses are fabricated from selected structural steels. Their rams are ground to obtain a fine 16 micro-inch finish. The units are provided with completely enclosed hydraulic systems which prevent fluid contamination. They are equipped with fine mesh screens to filter the oil supply. All fittings and connections are designed to contain the high pressures developed during work cycles.

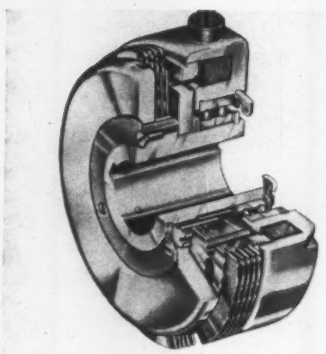
The work tables are also fabricated from structural steels. The firm says they can be moved through a wide range of travel by an easily-operated worm-gear reduction winch. This winch is self-locking and has a sealed and lubricated gear-train system. **—K–26**

Check Valves

A new line of check valves featuring SAE straight thread ports has just been announced by Fluid Controls, Inc.

The firm says the valves have large passages to permit full line flow and low pressure drop. The valve will not stick open because the spherically lapped poppet eliminates the need for close sliding fits. All parts are of steel and the body is one piece.

The valves are for service up to 5000 psi and burst pressures exceed 10,000 psi. Six sizes are available: 1/4, 3/8, 1/2, 1 and 1 1/4 in. tube. **—K–27**



Electro-Magnetic Clutch

A new electro-magnetic clutch, designated Model KA, has been announced by Twin Disc Clutch Co.

Licensed from the German firm of Ortlinghaus, the clutch will be sold and serviced in the United States and Canada exclusively by Twin Disc.

Model KA is a wet-type clutch designed for use in semi-automatic and fully automatic process machines as well as in program and tracer machines. It is said to permit an almost unlimited variety of spindle speeds, feed and traverse movements and directional changes. The company says compact design permits as many as 40 clutches to be incorporated in a single machine with mounting or motor shaft or countershaft as desired.

The new clutch operates on a simple magnetic principle in which annular flux is through the plates. This feature is said to provide high torque capacity and assures automatic wear take-up to eliminate adjustment problems. The steel driven plates have a "sine wave" conformation which overcomes residual magnetism and hydrostatic film strength; plates snap open the instant the coil is de-energized.

Ninety-volt d-c coils are standard with other voltage coils available for special requirements. **—K–28**

Fan Sets

A line of V-belt driven fan sets has been announced by Clarage Fan Co.

The ready-to-run units are furnished with motor and drive integrated in one assembly. They are suited to supply or exhaust jobs—indoors or outdoors—for volumes to 25,000 cfm, static pressures through 2 1/2 in. and temperatures to 300 F. The firm says the units are fitted for ventilating, spot cooling, supplying process air, and exhausting fumes in buildings of all types, all sizes.

Type LS units have low speed, forward curved multiblade wheels and are offered in 13 sizes; Type MS have medium speed backward inclined blade wheels and are available in 12 sizes. **—K–29**

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BUSINESS NOTES
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PlanetGear 24-Hour Clock

Haydon Instrument Co. has introduced the first in a series of custom designed 24-hour clocks.

This new clock, with split seconds graduated to .02, features the firm's unique PlanetGear drive which, the company says, can't skip or miss a number because the gears are always in mesh.

Since the torque required to drive the clock is uniformly low, its timing motors may be of the miniature series which are available in 115 v, 50, 60, 400, and 500 cycles.

The drums and bearings are made of nylon. The various shafts are made of centerless ground stainless steel. Preset of hours and minutes is made by means of a 12 v d-c high speed motor, push button actuated. The split seconds are set by a manual reset knob.

The numbers are 3/8 in. high to MIL-S-33558 stamped either white on black or black on white. Florescent numbers may also be provided. **—K–30**

Dust Collector

A new vertical tube mechanical dust collector, especially designed to be free from plugging for use in cement plant applications, is now available from American-Standard Industrial Div.

Designated the American Blower Series 345 dust collector, the new unit contains 15-in. vertical steel inlet tubes. These large diameter tubes are designed with an engineered tapered outlet. Although specifically designed for use in main kiln or clinker cooler cement plant installations, the collector is recommended by the firm for any application where tube plugging in smaller tube collectors is normally a problem.

Collection efficiency is compatible with normal primary collector requirements where a secondary electrostatic precipitator or silicone glass bag is to be utilized, the company reports.

The collector is of all-welded construction. It is factory-assembled and its design utilizes the sectionalized or modular construction concept whereby each unit is built up as a combination of collector sections to meet a specific set of dust collection requirements. **—K–31**

Limit Stop Assembly

PIC Design Corp., a subsidiary of Benrus Watch Co., has announced the introduction of a compact, heavy duty limit stop assembly.

Available from stock, the X2 type units are made to MIL-Specifications and are available in both ball bearings and oil-less bronze bearings with a range of mechanical stop limits from 30 to 4530 deg.

The units are self adjustable for fine zero adjustment. The firm says they are good for stopping torques up to 500 in-oz. **—K–32**

Chace THERMOSTATIC BIMETAL
ACTUATES ANOTHER PRECISION PRODUCT

The Therm-O-Disc ADJUSTABLE FURNACE FAN CONTROL

Thermo-O-Disc, Inc. Mansfield, Ohio

The Type AF-3 Adjustable Furnace Fan Control is a new product of Therm-O-Disc, Incorporated, for use with (or without) their similar adjustable or non-adjustable Furnace Limit Controls. This equipment stresses dependability, thermal sensitivity, and trouble-free life, plus adjustability within a range of 90°. The pointer indicates the turn-on temperature of the blower. Its snap-acting switch mechanism and heavy-duty contacts provide high electrical ratings up to 300°F., with full load amperages of 8.0 and 4.0 at 115 v. and 230 v. respectively. The control is listed by UL and C.S.A. An outstanding feature is the Chace precision bimetal sensing element which is mounted well into the air stream and provides quick response to temperature change.

In our more than a third of a century as producers of precision thermostatic bimetal, we've known and supplied hundreds of manufacturers of temperature actuated devices. Many have come from modest beginnings to become important factors in their industries and important customers of W. M. Chace Company. We are grateful, not only for their continuous patronage, but also for the millions of opportunities their combined sales have given us. For each product in the hands of a consumer is another chance for us to prove to our customer that his choice of Chace Thermostatic Bimetal was a good one. Whether he buys coils, strips or completely fabricated elements or assemblies of his design, he knows he can launch his new product with complete assurance, if the actuating element is Chace Thermostatic Bimetal.

While your new temperature actuated device is in the preliminary design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal." It's full of design engineering data with illustrated examples of uses of bimetal. Remember, too, that our 29 types of precision bimetal are available in strips, coils or completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:

- Freedom from Backlash
- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- No Lubrication
- No Wearing Parts
- No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Press-Drive Motors

New press-drive motors, Type WPD, from 1 to 300 hp designed for metal cutting and forming machines are available from Westinghouse Electric Corp.

The motors are all high slip, high-starting torque and low-starting current and are recommended by the firm wherever extremely dirty atmosphere or high concentration of oil moisture or chemicals are present.

In frames 182 to 8120, these motors are constructed in four general types—dripproof, totally enclosed fan-cooled, explosion-proof, and forced-ventilated motors.

Dripproof motors have heavy cast-iron frame and brackets. Both brackets have air openings in the under side of the bracket. The use of single-end ventilation, frames 182–326, eliminates need for openings in the frame, the company states.

Totally enclosed, fan-cooled motors have no ventilating opening. Cooling is accomplished by an external fan which forces air over the outer surfaces of the motor. A cast-iron hood encloses the fan. The motors use the heat exchanger principle in cooling. **—K–33**

Gear Blank Checker

A new method for checking bevel gear blanks has been developed by the Gleason Works.

The method involves a new system of inspection tolerances. Besides eliminating an important source of error in earlier systems, the firm says, the new tolerance system allows the use of its versatile No. 15 bevel gear blank checker, a universal fixture for checking all bevel and hypoid gear blanks.

The new inspection system eliminates the crown (or outside diameter) as a reference surface, since this surface cannot be located accurately once a radius is turned on the crown. It deals only with face angle and back cone angle, and yields results entirely consistent with good running qualities, and with design tolerances, the company says. It is not necessary to change existing design drawings, or existing systems of design tolerances.

The blank checking machine uses simple dials and wheels to replace earlier hand operations. The gear blank is mounted on an arbor on the work spindle table. The table has a horizontal adjustment and double dial for setting the outside diameter. The measuring head has a vertical adjustment with a double dial for setting the crown-to-back dimension. **—K–34**

Relief Valves

Watts Regulator Co., has announced a new line of ASME rated pressure safety relief valves for hot water space heating boilers.

Available in $^{3}/_{4}$ to 2 in. sizes, the No. 740 series have large internal flow areas and expanded outlets. The company says extremely high discharge capacities make them suited for boilers which previously required larger size valves for sufficient protection. **—K–35**

Cleaner-Transparentizer

CTS, a liquid for transparentizing, cleaning and sealing intermediates and one-sided materials, is now being marketed by Ozalid Div., General Aniline and Film Corp.

The firm says the material is especially suitable for transparentizing opaque paper stocks for use as masters in making offset printing plates, diazo and silver emulsion reproductions, cleaning soiled records, restoring vitality to deteriorated paper, removing pencil lines and smudges from paper or linen and providing tamper-proof master file copies. **—K–36**

Analog-Digital Converters

Kearfott Co., a subsidiary of General Precision Equipment Corp., has announced the availability of extremely rugged shaft position-to-digital converters suitable for high and low temperature environments with high shock and vibration resistance such as that associated with missile applications.

The firm says the converters are available for such applications as latitude, longitude, azimuth or conventional angular shaft displacement conversion and for decimal count conversion. In addition, combination counter-converter assemblies providing both visual and electrical digital readout are available.

The exclusive drum design of the converters provides for large conversion capacity in the smallest possible size, the company reports. Typical units provide for non-ambiguous conversion up to 2^{15} in a unit diameter less than 1.5 in. and length of $1^{15}/_{16}$ in.

Other features of this new family of converters include: code transition point within $^{1}/_{3}$ bit of true angular shaft position; fully operational from −80 to 350F; withstands 18 shocks in 3 orthogonal planes; no skips during 5–500 cps vibration at ±10 g's; no skips during radial acceleration up to ±7.5 g's. **—K–37**

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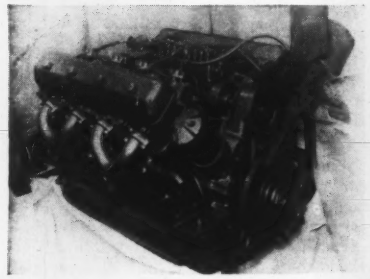
LATEST CATALOGS



Diesel Engines

Hercules Motors Corp. has introduced the first line of diesel engines designed specifically to provide low-cost efficient operation in light and medium trucks.

The firm says several of the new engines incorporate a new concept of a diesel combustion chamber that permits operation with a wide variety of fuels—including all grades of diesel fuel, kerosene, lubricating oil, gasoline, and jet aircraft fuel.

The new diesels range in size from 50 to 350 hp in three, four, six and eight cylinder models.

The firm says the new diesels for light and medium trucks range from 50 to 180 hp and are capable of handling loads up to 55,000 lb gross combination weight.—**K–38**

Pressure Reducing Valve

An external pilot operated steam pressure reducing valve has been announced by Klipfel Valves, Inc.

It is called No. KP-4, and is designed to meet requirements for use at most steam pressure reducing valve installations.

Features of the new valve include an AISI Type 440C stainless steel ball inner valve, perfectly spherical and extremely hard, which closes against a monel seat ring. The firm says this combination will withstand the wire-drawing effects of steam indefinitely. The tapered form of the opening between the ball inner valve and beveled seat ring increases the valve capacity by streamlining the flow of steam. —**K–39**

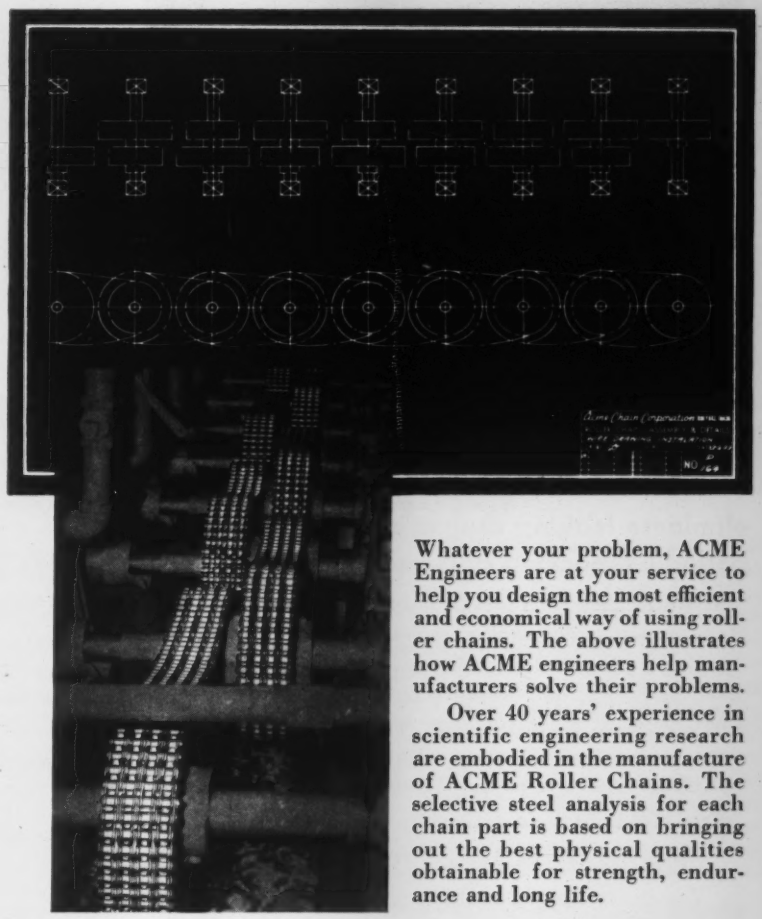
Miniature Vacuum Pump

Gelman Instrument Co. has announced a miniature pressure-vacuum pump developed as a compact lightweight vacuum pump for air sampling.

The pump has a capacity of 0.3 cfm free air and weighs 5 lb complete with motor. The vacuum mechanism is a small aluminum piston. Twin graphite rings on the piston maintain a vacuum seal and free the user of the necessity of lubrication, the company states.

The piston is direct coupled to a 1600 rpm split phase motor. The pump will produce 17 in. of vacuum or 20 lb. —**K–40**

YEARS OF ENGINEERING KNOWLEDGE AT YOUR SERVICE



Whatever your problem, ACME Engineers are at your service to help you design the most efficient and economical way of using roller chains. The above illustrates how ACME engineers help manufacturers solve their problems.

Over 40 years' experience in scientific engineering research are embodied in the manufacture of ACME Roller Chains. The selective steel analysis for each chain part is based on bringing out the best physical qualities obtainable for strength, endurance and long life.

Write Dept. 11-B for new 100-page illustrated technical catalog including new engineering section showing 36 methods of chain adjustments.

Write direct or call your nearest ACME Distributor for prompt, efficient service. He has the full cooperation of our engineering department.

Acme Chain Corporation
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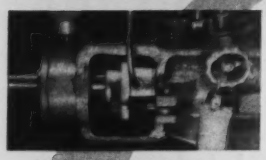
COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

SYNTRON

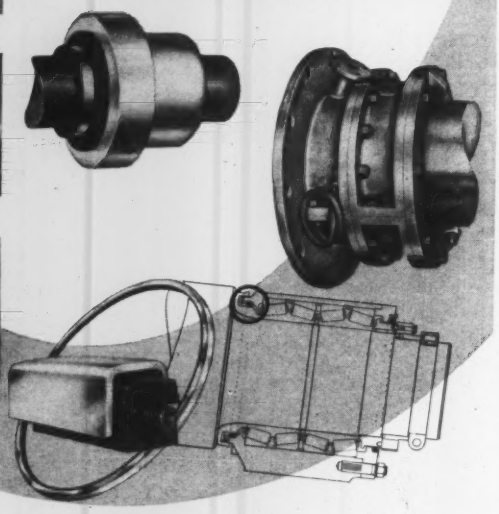
Mechanical SHAFT SEALS



on vacuum pump

on centrifugal pump

on condensate pump



eliminate leaking around rotating shafts — periodic repacking and maintenance

SYNTRON Shaft Seals provide a positive leak-proof seal around rotating shafts of compressors, pumps, turbines, engines, propeller shafts, roll necks, etc.

There's a SYNTRON Shaft Seal for every sealing problem whether it's for high speed shafts, hot, cold, corrosive or abrasive liquids, synthetic fluids, oil, toxic gases, sea water or just plain water and for every shaft size from ¼" to 48".

They are compact, completely self contained, ready to install—do not require periodic adjustments or maintenance—will not score or gall shaft.

SYNTRON Shaft Seals eliminate leakage and lower maintenance costs—

Write for free information on all SYNTRON Seals

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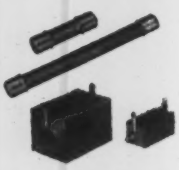

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SELENIUM & SILICON POWER UNITS

HOPPER LEVEL SWITCHES

FLOW CONTROL VALVES

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Hydraulic Pumps

Hydraulic system pressures to 4000 psi full flow, with fluid temperatures to 550 F are maintained by a line of hydraulic piston pumps recently developed and produced by Pesco Products Div., Borg-Warner Corp.

This new dual-element pump, known as Model 013673–010, is claimed to have maximum reliability for use in high pressure, high temperature aircraft engine main hydraulic systems. The design incorporates two independent pumping elements within a single body, both driven by a common drive shaft. Positive protection against failure is claimed to be afforded by the twin pump elements, each of which is capable of supporting full system pressure demands. **—K–41**

Vacuum Frame

An improved model of its traveling light vacuum frame, designed to save time, work, and floor space while increasing print production, has been introduced by Charles Bruning Co.

The new model is an automatic, self-contained unit for exposing all light-sensitive materials in the horizontal position. The firm says it offers the advantages of flat, pressure, contact printing plus new operator conveniences and the assurance of evenly exposed prints every time. **—K–42**

BUSINESS NOTES

Acquires Automatic Devices Co.

American Machine and Metals, Inc. announces that it has purchased the assets of Automatic Devices Co., of Western Springs, Illinois, except for the company's plant which it has leased.

Automatic Devices develops, designs, manufactures, and markets heating, cooling, and air conditioning controls for residential, commercial, and industrial buildings.

Opens Beaumont Facility

Clark Bros. Co., one of the Dresser Industries, has announced the opening of a new turbo repair facility in Beaumont, Texas.

Located at the plant of Ideco, Inc., another Dresser Division, the new Clark operation is an extension of existing facilities for the packaging and final assembly of field compressors. The shop is designed to assist the users of centrifugals in holding downtime to a minimum, and to give rapid repair service during plant turn-arounds.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Company Formed

Formation of Harbison-Carborundum Corp. by Harbison-Walker Refractories Co., Pittsburgh, and The Carborundum Co. of Niagara Falls, has been announced.

Harbison-Walker, world's largest refractories manufacturer, and Carborundum, a principal factor in the abrasives market and a leader in the manufacture of super refractories, will pool their refractories technology and sufficient financial resources to establish a jointly owned subsidiary for the engineering, manufacture and sale of fused refractories.

Fuller Co. Expands

An enlargement of its Southern division to cover new markets and provide increased customer service has been announced by Fuller Co.

Main headquarters will be in Birmingham, and the expanded territory will include most of Texas, Louisiana, and Arkansas, and will involve the opening of a new district office in Houston. The division now encompasses Tennessee, Mississippi, Alabama, Georgia, South Carolina, Florida, and New Orleans.

LATEST CATALOGS

Chemical Lubricant

Kano Laboratories has issued literature on Kroil, a chemical lubricant that dissolves rust, supplies necessary lubrication and loosens frozen parts.

According to the company, the material creeps into millionth-inch spaces. It is available in gallon quantities with trigger squirt gun. —K–43

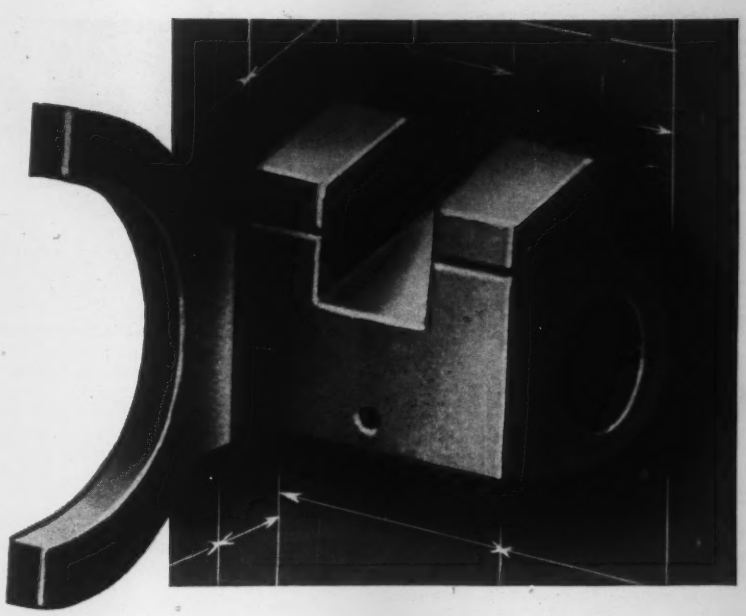
Heat Treating Unit

Ipsen Industries, Inc. Literature describes an automatic high vacuum cold wall type furnace with a work space 10 in. diam and 14 in. deep. Maximum operating pressure is 0.1 micron Hg; input is 25 kw. Maximum operating temperature is 2500 F. The unit is adaptable for high temperature copper or nickel brazing of stainless assemblies. —K–44

Clutches, Take-Offs

Rockford Clutch Div., Borg-Warner Corp., has issued a bulletin illustrating and describing its clutches, power take-offs and gear reduction units.

Data is given on spring loaded, over center and multiple disk clutches, along with specifications in tabular form and diagrams on the take-offs and gear reducers. —K–45



this new part brings outstanding cost reductions...

The photograph is of a shifter fork used in the transmission of a very popular garden tractor in volume production.

Clearly evident is the economy that can be achieved by powder metallurgy over other previously used methods. The elimination of practically all machine work effects striking cost reduction.

Made of pure powdered iron, infiltrated with copper to give added strength and ductility, this part is intended to meet the higher physical properties of wrought metals.

The user of this part naturally presented his problem to Bunting first.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

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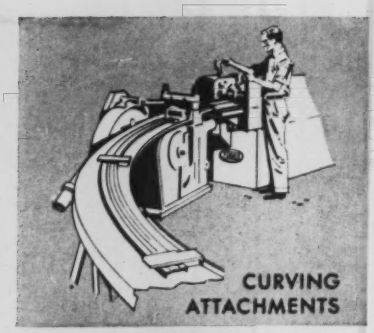
BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS



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COLD ROLL-FORMING
EQUIPMENT

for profitable mass production

High speed, YODER Cold Roll-Forming machines are the most economical method for mass producing structural or ornamental shapes. One machine with one operator can form up to 40,000 feet of shapes per day. Even on a part-time basis, a YODER Cold Roll-Forming machine can prove to be a profitable investment.

YODER flexibility works for you too, curving, coiling, ring forming, multiple roll-forming and embossing—on a wide variety of metals—can be incorporated into your production line. Practical, YODER-engineered design minimizes maintenance and downtime... assures uniformity, accuracy and reliability of your end product.

In addition to Roll-Forming machinery, YODER also makes a full line of Rotary Slitting equipment, Pipe and Tube mills. Send for the fully descriptive Cold Roll-Forming Book.

THE YODER COMPANY
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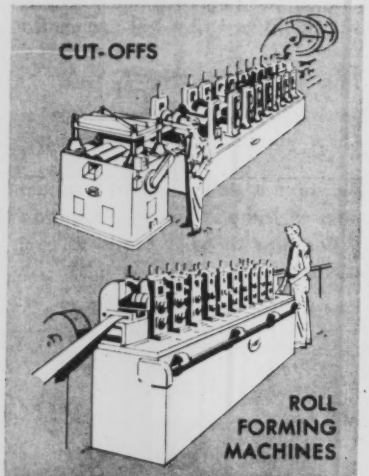

ENGINEERING YODER MANUFACTURING
COLD ROLL
FORMING
MACHINES

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BUSINESS NOTES
LATEST CATALOGS

Cooling Tower

Bulletin No. KT-104 describing Kennard/Nelson cooling towers, induced draft, has been released by American Air Filter Co.

The bulletin explains the construction, specifications, and performance details for the cooling towers with a centrifugal-type fan for quiet indoor and/or outdoor operation. Data is given to the centrifugal-type fan, the fan motor, mounting base and V-belt drive, "Z"-formed eliminators, wetted deck surface, and one-piece welded sump pan. **—K-46**

Hose Fittings

Parker Fittings & Hose Div., Parker-Hannifin Corp. has issued a four-page folder containing information for selection of industrial hose and fittings in regard to hydraulic pressures and other operating conditions.

Five types of reusable fittings in a variety of ends are illustrated. For assemblies with permanently attached ends, 13 kinds of hose and 13 different ends are shown. Also presented are hose fittings adapters and hose assembling equipment. **—K-47**

Ground Support Equipment

Ground support equipment systems, components and capabilities for aircraft and missiles are described in a four-page brochure available from Lear, Inc., Contracts Div.

The basic building blocks described in the brochure are available for use as either components in themselves or as groupings for complex systems. **—K-48**

Vibration Inducers

Martin Engrg. Co., announces a 38-page catalog which provides engineering data, specifications and a price list on its line of vibration inducers.

It lists 52 sizes and types from the BD-10 ($4^1/_2$ oz) to the 3000 lb impact CCVP series hopper car shaker (72 lb). Units are available in five motive powers: pneumatic, electric, gasoline, hydraulic, and steam. **—K-49**

Boiler Tabulation

Boiler Engineering & Supply Co., offers a boiler bid tabulation form titled "Comparative Boiler Installation Costs."

Printed in two colors on double size accounting-style sheets, the two-page form has separate sections headed Boiler & Trim, Burner & Controls, and Labor For Installation. Space is provided for tabulation of three competitive bids with a separate column remaining at the far right for remarks. **—K-50**

Pneumatic Conveyors

National Conveyors Co., has issued two catalogs.

P-60 shows uses of pneumatic conveyors for ash removal in steam plants; collection, processing and reclamation of cutting oils, chips, and borings, and the handling of dry materials. C-60 contains illustrations and discriptive data on ChipVeyor systems for turnings and borings, oil reclamation systems, finished parts reclamation and small parts handling systems. **—K-51**

Butterfly Valve

The Henry Pratt Co. Bulletin 10MB is a new catalog which illustrates and describes the new Monoflange Mark II rubber seat butterfly valve, designed to be the ideal working tool for engineers and users of this type of equipment. Complete specifications, certified dimension drawings, water flow data, gas flow data, weights and freight rates, and prices are included. **—K-52**

Precision Balls

Hartford Steel Ball Co., has released a new precision ball catalog which includes new AFBMA ball standards.

The catalog has cross referenced the new standards to the previous ones dated July 1956. It also contains a master table of ball grades and tolerances. **—K-53**

Definitions of Occupational Specialties in Engineering

This book contains comprehensive data related to all activities and specializations in engineering including specific knowledge and duties, responsibilities and related techniques necessary for successful performance in each field.

The ten activity fields defined are research, design, development, testing, procurement, production, construction, operation, administration, and teaching.

Major engineering fields of specialization defined include aeronautical, automotive, ceramic, chemical, civil, electric and electronics, guided missiles management, marine, materials, mechanical, metallurgical, mining, naval, nuclear reactor, ordnance and armament, petroleum and fuels and power plant engineering. Other engineering fields defined are: packaging, photogrammetry, agriculture, geology, and geophysics.

Pub. 1952 Price: $2.50, 20% less to ASME members.

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1	18	33	43	151	164TL	174, 175	189B
2	19	34	44	152	165TR	177	190
4	24	35	45	153	166	178	199
6, 7	25	36	46	155	167	179	201
8, 9	26	37	47	156	168L	183	202
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K-4	K-14	K-24	K-34	K-44	K-54	K-64	K-74	K-84
K-5	K-15	K-25	K-35	K-45	K-55	K-65	K-75	K-85
K-6	K-16	K-26	K-36	K-46	K-56	K-66	K-76	K-86
K-7	K-17	K-27	K-37	K-47	K-57	K-67	K-77	K-87
K-8	K-18	K-28	K-38	K-48	K-58	K-68	K-78	
K-9	K-19	K-29	K-39	K-49	K-59	K-69	K-79	
K-10	K-20	K-30	K-40	K-50	K-60	K-70	K-80	

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
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Industrial Controls

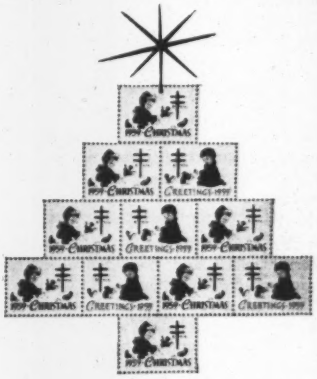
General Controls Co. has issued a catalog covering automatic temperature, pressure, level and flow controls, counters, switches, and automation controls.

Other items illustrated and described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators. A section covers the firm's Hydramotors, electro-hydraulic actuators having many patterns, designs and valve body materials. **—K–54**

High-Strength Steel

A technical bulletin on engineering and maintenance applications of a prehardened, machinable high strength steel, Viscount 44, has been prepared by Latrobe Steel Co.

The steel is supplied prehardened at a hardness range of Rockwell C 42-46. It meets high strength requirements up to 200,000 psi without further heat treatment. It is described as being basically an AISI-SAE Type H-13 steel with a high vanadium content, plus carefully controlled and evenly dispersed alloy sulphides. **—K–55**



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The greatest gift to find under the Christmas tree is the gift of good health. You have helped bestow the gift of health with Christmas Seal contributions. Medical progress against TB has saved eight million lives since 1907. But TB still kills thousands every year. Send your Christmas Seal gift today.

Fight TB with Christmas Seals

THOROUGH DUST COLLECTION!

Pangborn Dust Control eliminates float dust at Mexico Refractories

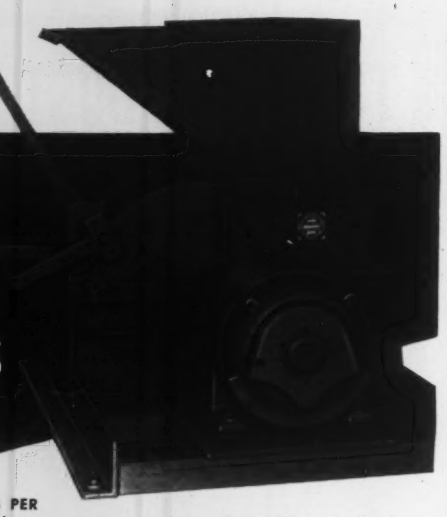
At Mexico Refractories Co., Div. of Kaiser Aluminum and Chemical Corp., Frostburg, Md., at least 7,000 tons of raw material a month pass through crushing, grinding and other dust-generating operations. To control and collect the resulting vast quantities of dust, two Pangborn Dust Collectors were installed.

These units provide thorough dust collection . . . every dust particle collected is returned to the process. As a result of Pangborn Dust Control, the air is free of float dust and good working conditions prevail. Although the company does not keep records on the amount of dust collected, it has found that salvage has been substantial. Mexico Refractories is highly satisfied with the effective, economical and trouble-free performance of Pangborn Dust Control.

If dust is a problem in your plant, talk to the Pangborn man in your area or write PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment—Rotoblast Steel Shot and Grit.*®

Pangborn CONTROLS DUST

NEW!



American

MODEL No. 1800

ROLLING RING METAL TURNINGS CRUSHER

- **FOR CAPACITIES UP TO 1½ TONS PER HOUR.** Designed specifically for plants which produce 20 to 200 tons of metal turnings per month. Engineered with the same long-life features as our larger models.
- **PAYS FOR ITSELF QUICKLY IN NEW PROFITS!** Turnings reduced to chips bring you $2 to $4 more per ton. Just 2 tons per day will bring a handsome profit over a year's time! Shovelling turnings, compared to long turnings release 30 to 50 more gallons of cutting oil per ton in the chip wringer. Chips are easier to handle and require only one-fourth the storage space.

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Valved Couplings

Features of its new 15 series of quick connect-quick disconnect valved couplings are described in a four-page catalog published by Snap-Tite, Inc.

The new line is designed for no-spill service in accordance with military specifications for use in airborne and ground hydraulic systems. Spillage, air inclusion, pressure drop, and envelope for the new couplings are all within specification requirements. **—K–56**

Universal Joints

Neapco Products, Inc. has released a 16-page engineering bulletin describing its line of universal joints and drives.

Three series are covered: light duty slow speed, hand operated joints through medium and heavy duty industrial and farm tractor power take-off drives. The bulletin contains specifications such as dimensions, performance ratings, drive shaft types, plus a list of standard yoke part numbers with data on bore sizes, keyways, setscrew holes. **—K–57**

Universal Die Base

A catalog describing a new type of die base for its Type CJ hole punching units, which cuts replacement cost of round and shaped dies by approximately 50 per cent, is now available from Wales-Strippit, Inc., a unit of Houdaille Industries, Inc.

A description of the new die base, which replaces the previous one-piece pedestal dies, and the relatively low-cost die buttons used in the base, is covered. Detailed dimensions and specifications are shown. **—K–58**

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Bronze, Iron Valves

Bronze and iron body gate, globe, and check valves for heating, piping and air conditioning systems are illustrated and described in a circular released by Fairbanks Co., 393 Lafayette St., New York 3.

It includes valves with pressure ratings from 125 through 300 lb pressure rating. The description of each valve provides application, basic design features, and standard sizes. In addition to the conventional screwed and flanged end valves, threadless valves, for soldered or silver brazed connections, and Underwriters' approved valves are also shown. **—K–59**

Grinding Wheel Balancer

A fast and accurate method of balancing grinding wheels with simple portable equipment, offering time-savings up to 80 per cent, is described in a four-page illustrated bulletin available from Aero Supply Mfg. Co.

Bulletin 2260 includes step-by-step photos showing how the new balancer is used to balance grinding wheels in less than 30 minutes, without removing the wheel from its machine, without need for extra labor or chain hoists and with repeated accuracy within 0.000040 in. displacement. **—K–60**

Belt (Stream) Weigher

A pneumatically-operated belt (stream) weigher for the continuous weighing of dry materials at low to medium rates is the subject of a bulletin by Omega Div. B-I-F Industries, Inc.

The Pneu-Weigh, Model 36–20W, is designed for continuous process industries, food processors, feed and flour mills, fertilizer, plastics and chemical plants. It has a range of 10:1 with constant speed drive and 50:1 with variable speed belt drive, and a capacity of 0 to 3000 lb per minute. A pneumatic sensing device makes the feeder adaptable for recording, pacing, and controlling other equipment. **—K–61**

Separating Equipment

Publication of a four-page bulletin containing details and specifications on its line of separating equipment for barrel finishing operations is announced by Techline Div., Wheelabrator Corp.

The bulletin contains information on new Model 3550 magnetic separator, a compact, low-cost answer to those installations in which the size of the part, or holes and recessed areas in the part, make impossible the selection of media that would permit mechanical separation. Also covered are the Model 2448 motor-driven mechanical separator which features an exclusive steel plate punched with round holes in place of the usual wire mesh screen, and the manually-operated shaker-type separating table for lower volume production. **—K–62**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Heat Resistant Castings

A set of data sheets giving property information on heat resistant cast high alloys has been published by the Alloy Casting Institute.

Central feature of the new data is a listing of room temperature and elevated temperature properties of each of the cast heat resistant alloy grades. In addition to specific property data, each of the 14 sheets gives a concise discussion of the applications, design and fabricating characteristics of each alloy. Metallurgical structure and characteristics of each alloy are completely described. —K–63

Lubrication Systems

A new catalog on its line of Multi-Luber automatic power lubrication systems for trucks, trailers, material handling equipment, farm implements and industrial machinery has been published by Lincoln Engineering Co., Div. of McNeil Machine & Engineering Co.

Catalog No. 50 includes illustrations and specifications pertaining to air-, vacuum- and manually-operated systems, their various applications, methods of operation, and listings of component parts and accessories. —K–64

Industrial Fasteners

Die cast threaded fasteners are described in an eight-page catalog published by Gries Reproducer Corp.

The firm says the many types of fasteners—obtainable only on special order from sources using conventional metalworking methods—are offered as standard, stock items. This is possible because of the firm's technique of automatic high-speed production of highly precise die cast zinc alloy and molded nylon units, the company states. —K–65

Pointers, Indicators

Information on the firm's line of pointer and indicator gages is contained in a series of product specification sheets available from Hays Corp.

The bulletins cover specifications and data concerning Models 211, 212, and 213 pointer gages and Model 214 vertical scale indicator. The gages employ a diaphragm-type measuring element for low pressure, draft, or differential pressure measurement to 120 in. water. —K–66

Air Compressors

A bulletin covering WN-224 heavy duty industrial air compressors is available from Joy Mfg. Co.

Included are specifications and dimensions in six basic models ranging from 350 to 1250 hp and 2418 to 7392 cfm. The unit's semi-radial design features are exhibited in a two-page cross section drawing. Installation photographs are included. —K–67

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STAINLESS STEEL
"MNH" FLEXIBLE CONNECTORS

A NEW stock answer to pipeline problems caused by rigid connections.

- Dampens Vibration
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3793 Ninth Street, Long Island City 1, New York • 'phone: STillwell 4-5173

Fluid Mixing Eductors

Bulletin 2M-S published by Schutte and Koerting Co., describes the company's mixing eductors equipped with regulating spindles.

The eductors are designed to perform intimate mixing, blending, or emulsification of two fluids. The firm says that most commonly the fluids handled are two liquids, but they may be a liquid and a gas, or a liquid and a slurry. The regulating spindle provides for throttling of the motive (higher-pressure) liquid flow over a wide range of load conditions. Normally these eductors accomplish the mixing without requiring pumping in the suction fluid line. —K–68

Fuel Pumps

A new series of fixed displacement, balanced vane type fuel pumps for jet engines is described in a four-page brochure released by Vickers Inc., Div. of Sperry Rand Corp.

The brochure features the design and performance characteristics which enable these new pumps to exceed stringent military specifications for contamination tolerance and service life requirements while effecting significant weight savings of up to 10 to 25 per cent. —K–69

For Consulting Engineers
Turn to Page 198

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AMERICAN CANCER SOCIETY

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Control Systems

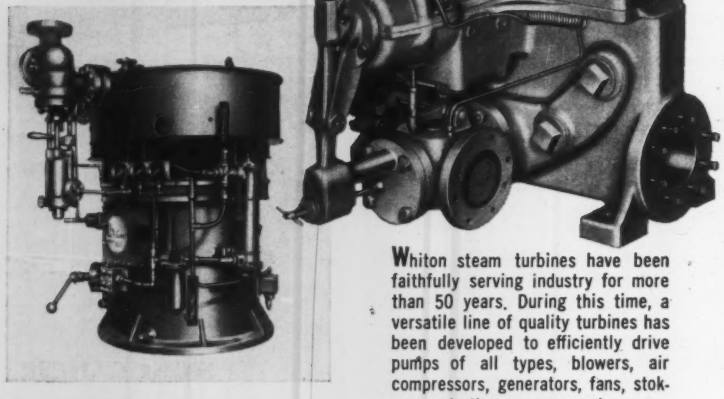
Systems for full-scale automatic control in plants, refineries, and pipelines are described in a four-page bulletin, No. 3019, published by Consolidated Systems Corp., a subsidiary of Consolidated Electrodynamics Corp. —K-70

Alloy Metals

Meehanite Metal Corp. has available a 20-page illustrated booklet that includes alphabetical tabulations showing specific replacements of alloyed irons, steels, brass, bronze, and forgings as well as type of Meehanite metal used in such applications. —K-71

Whiton COMPLETE TURBINE Versatility

- both horizontal and vertical designs
- from fractional to 1200 HP
- for industrial and marine applications



Whiton steam turbines have been faithfully serving industry for more than 50 years. During this time, a versatile line of quality turbines has been developed to efficiently drive pumps of all types, blowers, air compressors, generators, fans, stokers, and other process equipment.

Equipped with such features as constant speed governor, separate overspeed emergency stop and dynamically balanced rotor, speeds are obtainable to 8500 RPM suitable for steam pressures to 1250 psig and temperatures to 1050° FTT.

For complete specifications, contact The Whiton Machine Company or the Whiton representative nearest to you.

Whiton SINCE 1856

THE WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT

Foundry Exhaust Hoods

A 28-page manual of exhaust hood designs for the foundry industry has been released by American Air Filter Co.

Bulletin 270–E2A, Volume 2, contains 46 installation photographs which illustrate the use of exhaust hoods in foundry shakeouts, melting furnaces, grinding and abrasive sawing, swing frame grinding, abrasive cleaning and tumbling, sand handling and conditioning. —K-72

Precision Instrument Components

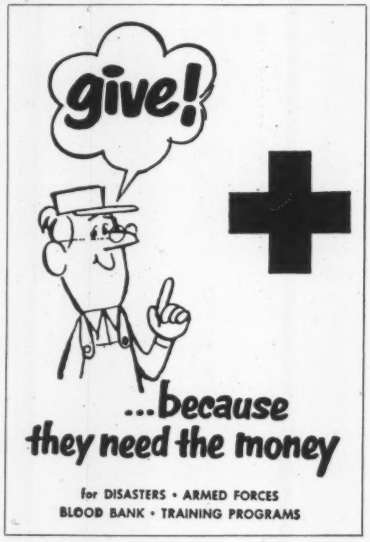
PIC Design Corp., a subsidiary of Benrus Watch Co., is offering, upon request, copies of its 416-page master Catalog No. 20a.

This catalog has been printed on special custom-made Bible-Leaf paper to reduce file and drawing board space. Consolidating all previous catalogs and supplements, the new catalog lists over 10,000 items, including gears, shafts, collars, couplings, speed reducers, differentials, and other precision items available from stock. In addition to detailed drawings, complete specifications and prices, the new catalog contains separate technical data, breadboard kit and precision tool components section. —K-73

Butterfly Valves

A four-page condensed bulletin describing its line of butterfly valves is being distributed by Continental Equipment Co., Div. of Fisher Governor Co.

Eight butterfly valve designs are presented in tabular form. Sizes range from 1 to 108 in. with pressure drops up to 1200 psi and temperatures up to 2000 F. —K-74



KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Pipeline Strainer

Bulletin 1210–1, released by Sarco Co., describes new self-cleaning pipeline strainers in sizes from 1/4 through 3 in.

Features of the strainer, Type BT, are high strength construction of the bronze bodies, long, tapered screen socket, perforated heavy gage with spot welded lap seams, built-in sediment collection chamber integral with cap, and 45 deg. blow-down connection angle. —K–75

Geared Counter

A four-page data sheet and application guide that describes the operation, uses and modifications available on a new line of high speed, quick reset geared counters has been announced by Veeder-Root Inc.

The new counter is available with a predetermining feature for automatic control of machinery and processes. Measuring 5 in. long, 2.6 in. wide and 2.8 in. high, it has a 5-digit window. As a predetermining counter, with electrical or mechanical stop action, it comes as a geared revolution counter or as a double wheel measuring counter. Its maximum speed is 6000 rpm or 8000 counts per minute. —K–76

Speed Reducers

Single-reduction worm gear speed reducers designed with a new high-load-capacity thread form and utilizing high-strength materials, are described in a 32-page illustrated catalog available from the De Laval Steam Turbine Co.

Catalog 3805 covers a line of Delroyd single reduction reducers which use worm and gear materials permitting the maximum ratings allowed by the new American Gear Manufacturers Association rating standard. The firm says the reducers also have an exclusive involute helicoid thread form with the highest load capacity of any type of worm gear. —K–77

Heaters, Furnaces

Reznor Mfg. Co., has published a new 28-page general catalog describing in detail its entire line of gas-fired heaters, furnaces, and packaged blowers.

The catalog, SA-5900, features a unique, illustrated two-page table of contents which enables the reader to select heaters and furnaces according to type, applications, capacities, and major features. —K–78

Die Cushions

A 16-page catalog describes the line of die cushions produced by Verson Allsteel Press Co.

Described are pneumatic, hydro-pneumatic and hydraulic types. Size and capacity data is given as well as information on typical die cushion arrangements. —K–79

Metal Treatment

Rusticide Products Co. has issued a four-page folder describing how the metal treatment Ospho, which when applied directly on rusted metal, stops rust action and provides a sound base for regular maintenance paint. —K–80

Sampling Valve

Data Unit No. 355, gives features, construction details, sizes, ratings, and materials of Jerguson Gage & Valve Co. No. 23 drain or sampling valve said to utilize a unique bolted bonnet for freeze-proof action under all conditions. —K–81

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Lapping-Polishing Machines

A catalog section on vibratory lapping-polishing machines has been issued by Syntron Co.

Illustrated section presents complete descriptions, specifications and data for four machines designed to provide easy, mechanical polishing of metallurgical samples for microscopic examination. The firm says the machines eliminate fatiguing, manual lapping and polishing. —K–82

Filtration Material

Scott Paper Co., Foam Div., has released data on its flexible polyurethane, Scottfoam, and its applications as a filter medium.

The company says the foam, unlike open urethane foams, has a three dimensional structure of skeletal strands. Its resilience and strength prevent strand displacement under normal use conditions, the firm says. The material is produced in six standard porosity grades and is available in thicknesses from $^1/_{16}$ to 6 in. in increments of $^1/_{16}$ in. —K–83

Iron Chromium Alloys

Alloy Casting Institute has issued a series of data sheets giving information on iron chromium alloys for heat resistant applications.

Specifications and properties of the various alloys are covered in tables and graphs for 14 alloys. Various mixtures of molybdenum and nickel are covered. —K–84

Air Circulating Units

High-level circulating units for redistributing warm air from ceilings to floor areas are described in a four-page bulletin available from L. J. Wing Mfg. Co.

Bulletin HLC-59 covers features and engineering data on units intended to put waste heat to work by recirculating warm air from high levels to floor level. The firm says the units may also be used for summer fresh air supply by addition of a duct intake from the roof. They may also be converted to unit heaters, by addition of a heating section and steam or hot water lines. —K–85

Tubular Conveyor

Hapman Conveyors Inc., has issued data sheets which describe the versatility of its tubular conveyors.

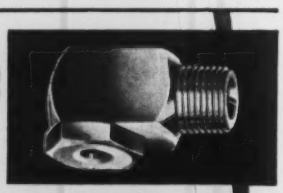
The package unit can readily be rolled to various locations to receive chips from the machine, drain the coolant from the chips, return the coolant to the machine by means of a built-in pump and carry the chips to a remote location. —K–86

Roller Bearings

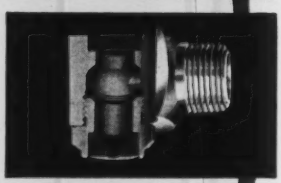
HJ series roller bearings, featuring a patented one-piece cage design, are described in detail in Catalog 359, now available from Torrington Co.

The firm says the unique cage design permits use of the new bearings at speeds higher than possible with conventional full complement roller bearings. In addition, longer and larger rollers make possible greater load capacities than heretofore available. The bearings are supplied with or without inner rings, and without inner rings may be applied directly to hardened and ground shafts. —K–87

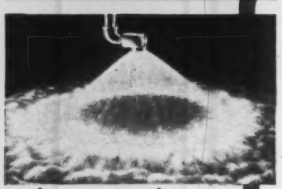
Spray Nozzle types
choice of over 12,000 basic designs



materials
brass, stainless steel, lead, hard rubber, hardened steel, tungsten carbide and many others.



performance
uniform distribution with spray angle, capacity, impact and atomization to your specifications.



to improve every spraying operation

Improve performance, lower spraying costs with Spraying Systems spray nozzles. Prompt delivery. For complete information write for Catalog 24.

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ADVANCED SPRAY NOZZLE DESIGN FOR NEW DIMENSIONS IN CONTROL AND PERFORMANCE

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Won't Leak
Shoots 3 Feet

Same formula as famous Kroil that has pleased 14,000 industrial users for 10 years or more.

Loosens stuck together metal parts, bushings, bearings, bolts, screws, pipe, etc., "anything from an embalmer's needle to a bulldozer," one customer said.

"Like an extra employee," said another. "Turned rust into mush, put $50,000 equipment back to work."

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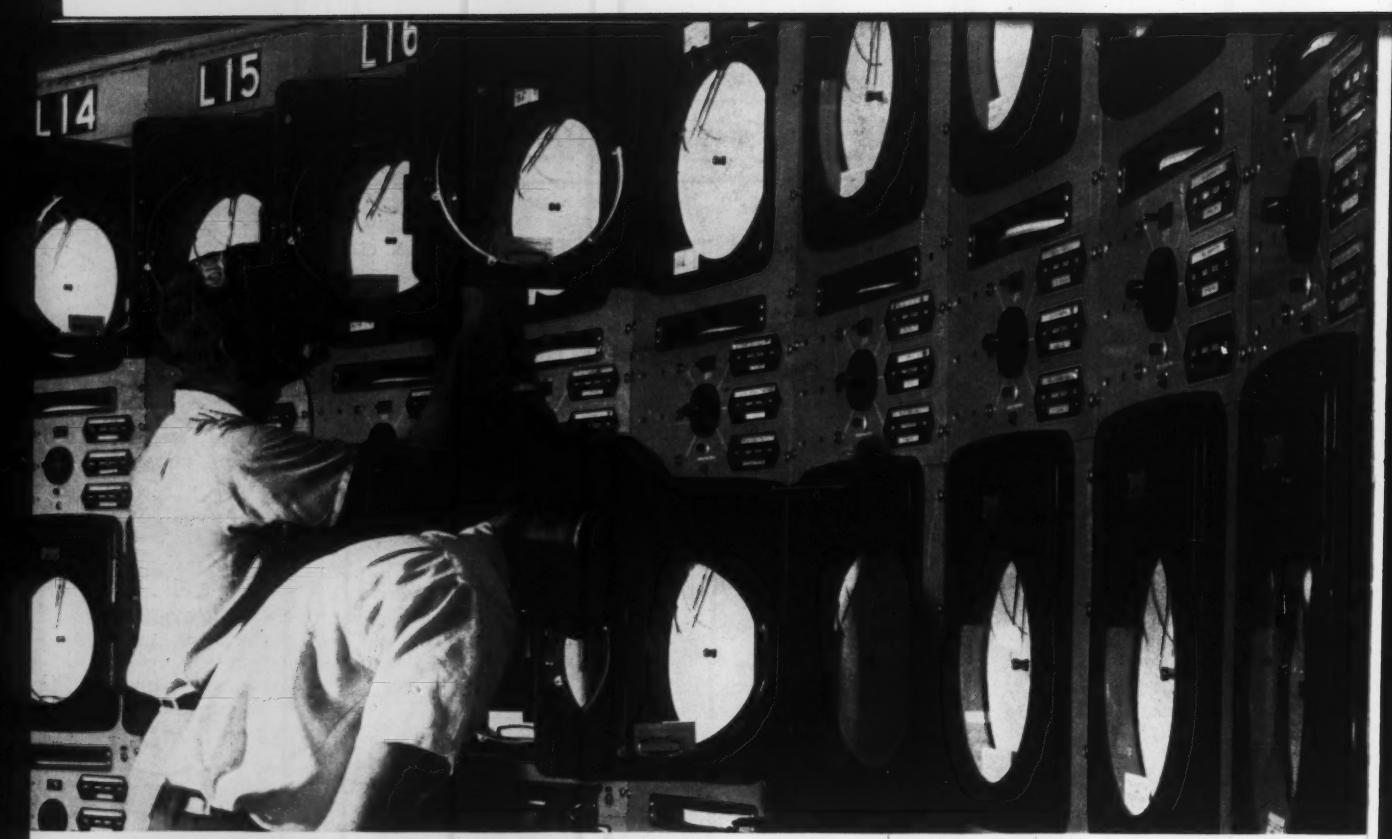

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ROCKETDYNE looks to DYNALOG* Electronic Recorders

Test-firing is a vital function at Rocketdyne, a division of North American Aviation, Inc. Rocketdyne manufactures liquid propellant rocket engines for the Army's Redstone and Jupiter missiles; the Air Force Atlas and Thor.

Rocketdyne is presently using over 1,000 Dynalog Electronic Recorders because they fit instrument requirements to a T. They're accurate within ±¼% of full scale. And because Dynalogs have no slidewire, Rocketdyne finds their maintenance problems practically eliminated. They prefer circular charts also, for faster, easier analysis of each measured variable after a test firing.

On heat treating processes, too, Dynalogs provide highly accurate, dependable recording and control of furnace temperatures. They're inherently free from "drift" and mechanical problems... have no dry cells or batteries to standardize or replace... require no lubrication or alignment.

Find out how Dynalog Instruments can improve recording and control of your own process. Write for Bulletin 20-10.
The Foxboro Company, 522 Neponset Ave., Foxboro, Mass.

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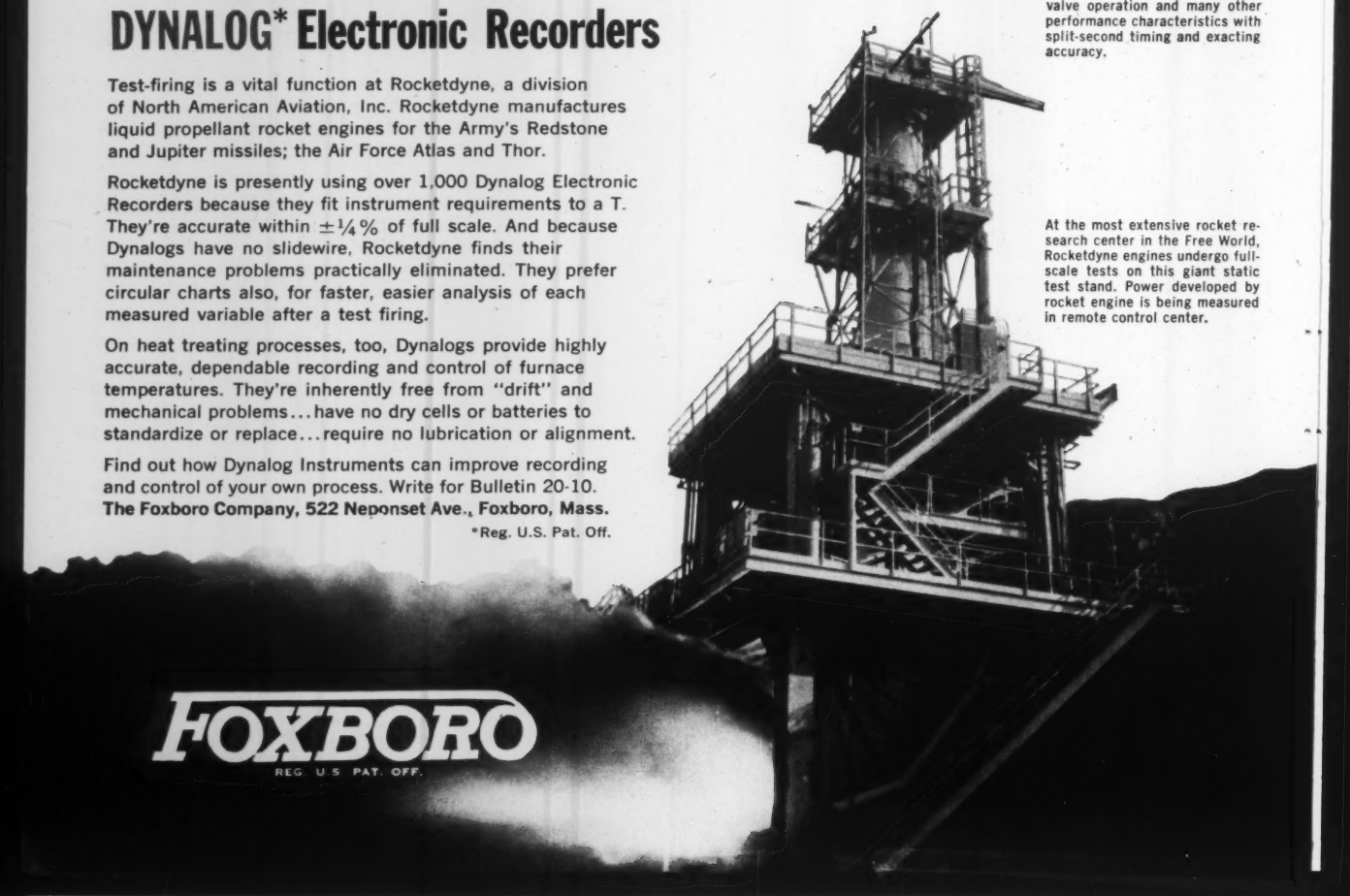
Some of the 150 Foxboro Dynalog Recorders used at Rocketdyne's Propulsion Field Laboratory. During each test, these instruments log critical data on engine thrust, temperature, valve operation and many other performance characteristics with split-second timing and exacting accuracy.



At the most extensive rocket research center in the Free World, Rocketdyne engines undergo full-scale tests on this giant static test stand. Power developed by rocket engine is being measured in remote control center.

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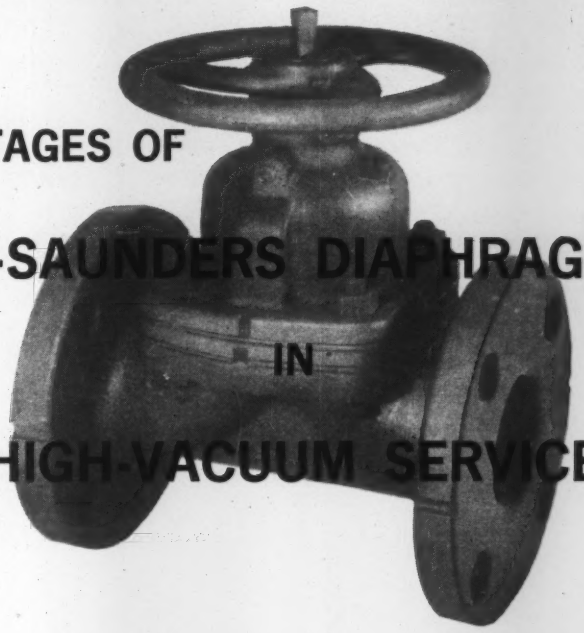
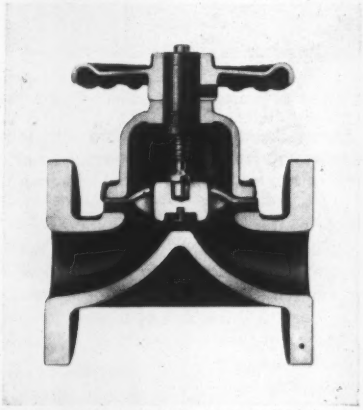
GRINNELL REPORTS ON VALVES:

THE ADVANTAGES OF GRINNELL-SAUNDERS DIAPHRAGM VALVES IN HIGH-VACUUM SERVICE



Dependable performance and long service life for vacuums down to 0.1 micron . . . with leak rates of less than 0.1 micron cubic foot/hour

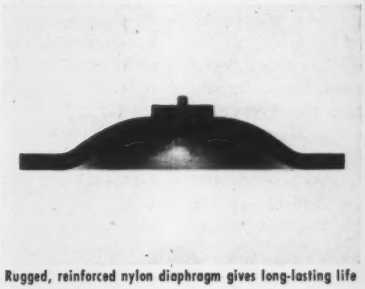
One of the most important requirements of valves for high-vacuum service is that they must be vacuum-tight at all times during their operating cycle. Diaphragm valves of the Grinnell-Saunders manufacture fully meet this requirement. When clamped between the flanges of the body and bonnet, the diaphragm is easily made vacuum-tight down to 0.1 micron — with an in-leakage rate of less than 0.1 micron cubic foot/hour. Whether in the open, throttling or closed position, the diaphragm presents a smooth, unbroken face to the vacuum side of the chamber.



Valve provides vacuum-tight seal in closed position

Rugged, nylon-reinforced diaphragms in a variety of materials

Grinnell has perfected a method of reinforcing its diaphragms with wear-resistant nylon. The result is a diaphragm that lasts longer at high-vacuum. The only part of the valve subject to service wear at any time is the diaphragm — which can easily be replaced in a matter of minutes, without removing the valve body from the system. Diaphragms are available in a wide choice of materials.



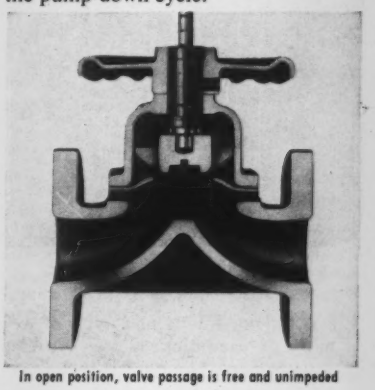
Rugged, reinforced nylon diaphragm gives long-lasting life

Contamination minimized

Construction of Grinnell-Saunders Diaphragm Valves provides separation of the working mechanism from the vacuum within the system. This isolation of lubricated working parts prevents contamination of the system from lubricant outgassing.

Large, unimpeded valve passage

The large passage of the Grinnell valve, in the open position, offers minimum impedance to the escape of random moving molecules in pumping down to high-vacuum, thus shortening the pump-down cycle.



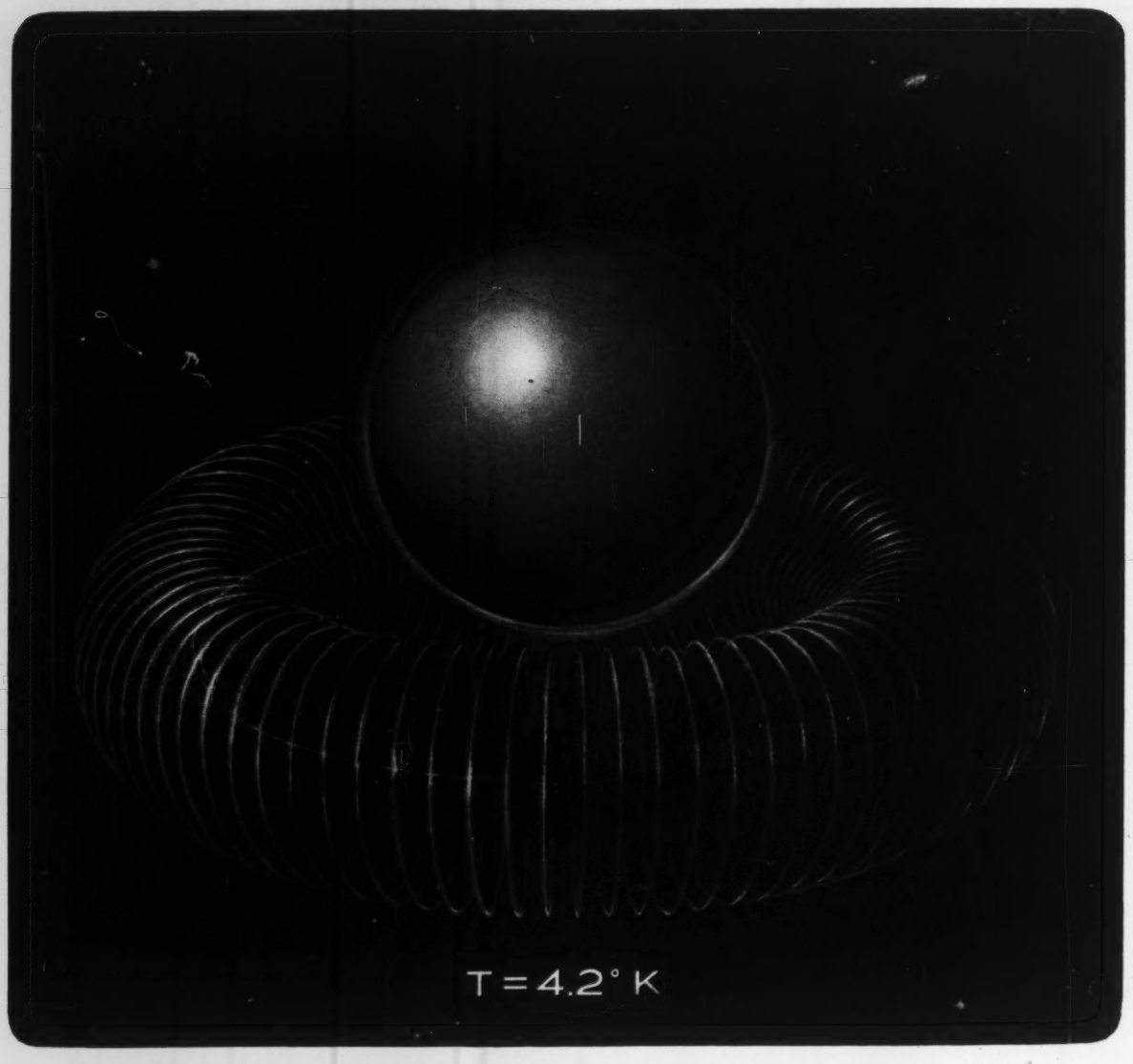
In open position, valve passage is free and unimpeded

Special provisions:

Sealed bonnets are available for evacuation when required. Elastomer type diaphragms do not require evacuation of the bonnet. Valves with plastic diaphragms, used at elevated temperatures, do require evacuation of the bonnet for long diaphragm service life.

For more information

Get further facts about Grinnell-Saunders Diaphragm Valves. Learn how the diaphragm lifts high for streamline flow in either direction . . . and how the diaphragm seals firmly against the body weir for leak-tight closure. Write to: — Grinnell Company, Providence 1, Rhode Island.



THE CRYOGENIC GYRO

A fundamentally new type of gyroscope with the possibility of exceptionally low drift rates is currently under development. The design techniques used in conventional electro-mechanical gyros appear to have been largely exploited. A break-through is needed, and the cryogenic gyro may well provide it.

The cryogenic (liquid helium temperatures, in the range of 4°K) gyro consists of a superconducting sphere supported by a magnetic field. The resulting configuration is capable of support in this manner as a result of a unique property of a superconductor. Exceptionally low drift rates should be possible. This cryogenic gyro has performance potential unlimited by the constraints of conventional electro-mechanical gyro.

This is just one example of the intriguing solid state concepts which are being pioneered at JPL for meeting the challenge of space exploration. In addition to gyro applications, superconducting elements are providing computer advances and frictionless bearings. The day of the all-solid-state space probe may be nearer than one realizes.

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Expansion Joint Design Moves out of the "Model T" Era

Badger first began fabricating packless metal bellows expansion joints more than 35 years ago. These "Model T" joints performed (and are still performing) with outstanding success in hundreds of process and steam line piping installations.

Starting in the 30's other expansion joint manufacturers entered the field. The most successful adopted many of the basic features of the original Badger design.

During the last decade, as industry's requirements became more stringent, and joint manufacturers gained fabricating and field experience, certain fundamental problems inherent in the early designs became evident. Most of these problems were solved through a series of modifications. (Among which was the Badger Directed Flexing Self-Equalizing Joint — the famous "DFSE" Design.) But, at best, the modifications were stop-gap measures which complicated the joints and greatly increased their weight. A fundamental reassessment of expansion joint engineering data was needed. Badger led the way: In 1956, a task force completed a three-year research program and the first S-R (Service-Rated) Expansion Joints were produced.

In the three years they have been available, S-R Expansion Joints have been both an engineering and a sales success. But like many revolutionary concepts which upset tradition, the full implication of the advantages S-R Joints offer is still not universally understood. The message that follows is an attempt "to set the record straight."

• • • • •

Equalization — fact and fiction

Many users of expansion joints are under the impression that the so-called "equalizing" rings on today's conventional type expansion joints distribute movement equally among all the corrugations of the bellows. It is argued that as the joint absorbs thermal movement, the tops of the rings progressively come into contact until the bellows is fully compressed thus limiting the amount of compression which any one corrugation can ultimately absorb (see diagram 1). In *this* sense the rings do contribute to the "equalization" of movement by physically limiting the compression of each corrugation to the distance between any two adjacent rings.

Diagram 1

Conventional Type Expansion Joint. Cross-sections of rings and bellows of a conventional "self-equalizing" joint showing cold and hot positions. Note that true equalization of movement can only be obtained when tops of all rings are in contact — an impractical and dangerous situation.

Note, however, that the degree of compression will not be truly equalized until the tops of all the rings are in contact. But, when such a condition occurs, serious problems will result. If the limit of compressibility is reached before the thermal expansion has been completely absorbed, exceedingly large forces will be transmitted through the pipe line to the anchors and connected equipment. On the other hand, if the joint is compressed only partially, not all of the corrugations will absorb movement to the same degree.

How S-R Joints solve equalization problem

Badger S-R Expansion Joints feature the new Curvilinear Corrugations which naturally assume an "all curve" shape under pressure (diagram 2), assuring more equal distribution of stresses throughout the bellows material. Furthermore, the shape, height and pitch of the corrugations are based on a carefully engineered correlation. Thus, reasonably equal distribution of movement among the corrugations is obtained, even in joints not equipped with reinforcing rings.

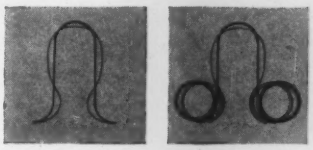

Diagram 2

Badger S-R Expansion Joint. Cross-sections of S-R Joints (Series 50 left, Series 150 right). The movement of the corrugations is shown by dotted and solid lines. Compare configuration and effective height of corrugations, position and size of rings with conventional joint.

Equalization of movement is inherent in the design and functioning of the bellows on Badger S-R Joints. On the basis of provable engineering criteria, the prime purpose of reinforcing rings of any design is to retain the hoop dimension (diameter) of the corrugations when they are subject to internal pressure. This Badger's simple, lightweight tubular reinforcing rings do. But, in addition, the new tubular shape of the rings does contribute to joint flexibility and life by permitting flexing over a more effective portion of the total corrugation height than conventional cast or fabricated equalizing rings.

Better performance, lower cost

Briefly, then, Badger S-R Joints alone offer these advantages: Better equalization of movement which results in elimination of localized stresses and leads to longer joint life; a simple, lightweight design that makes installation easier, eliminates cumbersome castings and fragile mechanical devices; complete range of sizes from 3" to 72" made from any workable metal and with a wide choice of accessories.

Badger S-R Joints are probably the answer to your problem. There's an easy and quick way to find out — ask the Badgerman for his recommendations. Write or phone today. Badger Manufacturing Co., 230 Bent St., Cambridge, Mass.

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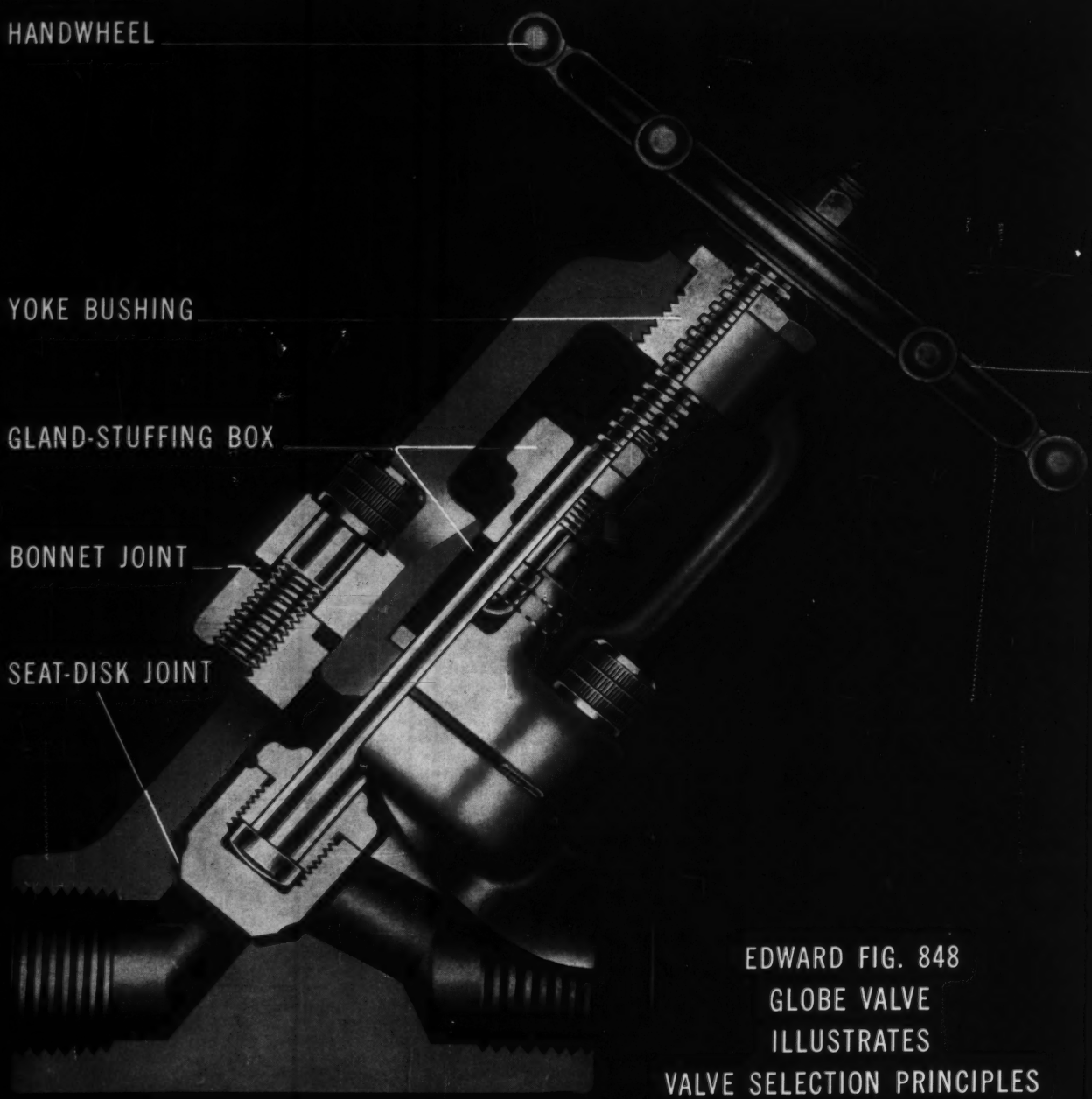
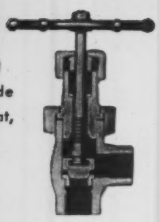
BADGER S·R EXPANSION JOINTS



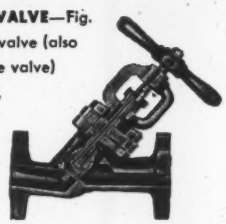
EDWARD FIG. 848 GLOBE VALVE ILLUSTRATES VALVE SELECTION PRINCIPLES

1 ANGLE VALVE—Fig. 2699, 600 lb at 900F (2000 lb WOG) with union bonnet, inside screw, replaceable seat, knobbed handwheel, and screwed ends. Sizes ¼" to 1".



2 UNIVALVE*—Fig. 2224, 1500 lb. at 1050 F (3600 lb WOG) or 2500 lb at 1050 F (6000 lb WOG) with outside screw, Impactor* handle seal-welded bonnet, integral seat and socket welding ends. Sizes to 2½".

3 BLOW-OFF VALVE—Fig. 641, straightway valve (also available as angle valve) 300 lb at 850 F, 600 lb at 850 F, 1500 lb at 850 F, with integral Stellite seat, flanged ends, bolted bonnet. Sizes to 2½".



What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

HOW TO SELECT FORGED STEEL VALVES

When you need forged steel globe or angle valves (2½" and smaller) for high-pressure and/or high-temperature applications, you can save money on your installations as well as reduce future maintenance expense by making sure you select the proper valve. Here are a few suggestions.

VALVE CONSTRUCTION DETAILS
(See large illustration, opposite page)

Valve Handwheel or Handle should be large enough to operate valve easily. Wheel spokes help keep handwheel cool. Knobbed design permits tight grip even with greasy gloves. Impact type handle will be helpful in obtaining tight closure for valves 1½ to 2½ in.

Yoke Bushing material should be checked. High-strength aluminum bronzes are usually best. Look for ample thread engagement between bushing and yoke and between bushing and stem.

Gland-Stuffing Box—Stuffing box with bolted gland assures good packing compression; hinged bolts swing out of the way but don't get lost. Be sure to get stainless steel bolts for maximum resistance to rusting, and for easy adjustment even after years of service. Packing chamber should be deep and not excessively wide.

Bonnet Joint of bolted construction is easiest to work with. You can disassemble and reassemble with pocket-size tools. Union bonnet is compact and usually less expensive for smaller valve sizes, but is not recommended for high temperatures. Bonnet gasket of soft iron performs well in most services but spiral wound metallic-asbestos gaskets are superior in high temperature services. For extreme pressure-temperature services welded bonnet joints for permanent tightness are desirable. Seal-welded type bonnet has advantage over fully welded design because it permits disassembly and reassembly.

Seat-Disk Joint—An integral hard-faced seat is generally regarded as superior to screwed seat construction because it eliminates body-seat leakage and retains hardness under temperature. A hard faced disk or disk of special alloy is desirable in high temperature services; but 13 per cent chromium stainless steel is an excellent all purpose material below 750 F.

Other Features to Evaluate—Valve compactness is important because you frequently find small piping located in crowded quarters. Inclined bonnet globe valves are less likely to erode due to high velocities—have less pressure loss. Valves of "inside screw" design (stem threads below packing chamber) are usually lower priced and give good service where temperature is not too high and where line fluids are free of sediment. But, best design and materials are useless without experienced workmanship and rigid quality control.

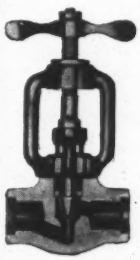
VALVE APPLICATION SUGGESTIONS

First, determine whether a standard valve will do the job before ordering expensive special designs. (Your Edward Representative can help you decide.) Often a slight modification of a standard valve, or a combination of standard valves, will do the job. Here are some facts about types of standard valves and their application:

- For many services, angle valves (illustrated by valve #1) reduce installation cost, minimize pressure drop, improve operational convenience. All Edward forged steel stop and stop-check valves from ¼" to 2½" sizes are available in the angle version.
- For high temperature, Edward forged steel valves with seal-welded bonnets (#2) permanently maintain pressure tightness without periodic tightening of bonnet joints.
- For blow-off service, or wherever double valving is required, select sets of valves of the same basic type with hard-faced seating surface for dependability, longer life and interchangeability of parts (#3).
- For permanent tightness, select an instrument valve (#4) with corrosion-erosion resistant hard-faced seat or a valve with stainless steel body. Bonnetless design requires less maintenance.
- Piston-type check valve (#5), available with union, bolted, or seal-welded cover, is best for most services because it will seat tighter, has easily repairable seat face.
- Modern globe and angle stop valves (shown here) are more dependable than gate valves where repeated drop-tight closures are required, may be used for approximate flow regulation and moderate throttling.

YOUR EDWARD REPRESENTATIVE will be glad to give you the complete story on these features, plus the many other advantages of Edward valves—such as positive, pressure-tight backseats, self-centering disks, special stem and packing materials, and many others. Edward builds a complete line of cast and forged steel valves for pressures to 10,000 lbs. For additional information write to Edward Valves, Inc., 1228 W. 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

4 INSTRUMENT VALVE—Fig. 952Y, 600 lb or 2500 lb at 850 F (6000 lb WOG) with swing bolted gland, socket welding ends, no bonnet joint. Sizes ¼" to 1".



5 CHECK VALVE—Fig. 5538, piston type, 1500 lb at 1050 F (3600 lb WOG) bolted bonnet, screwed ends, integral Stellite seat. Sizes ¼" to 2".

*T. M. Reg. U. S. Pat. Off.

EDWARD STEEL VALVES
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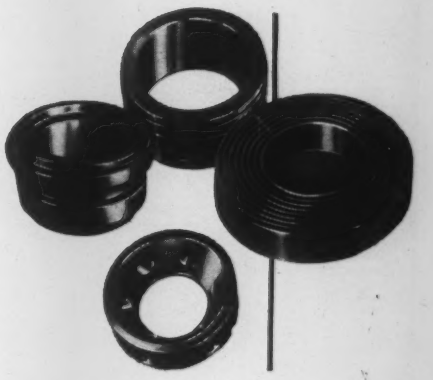

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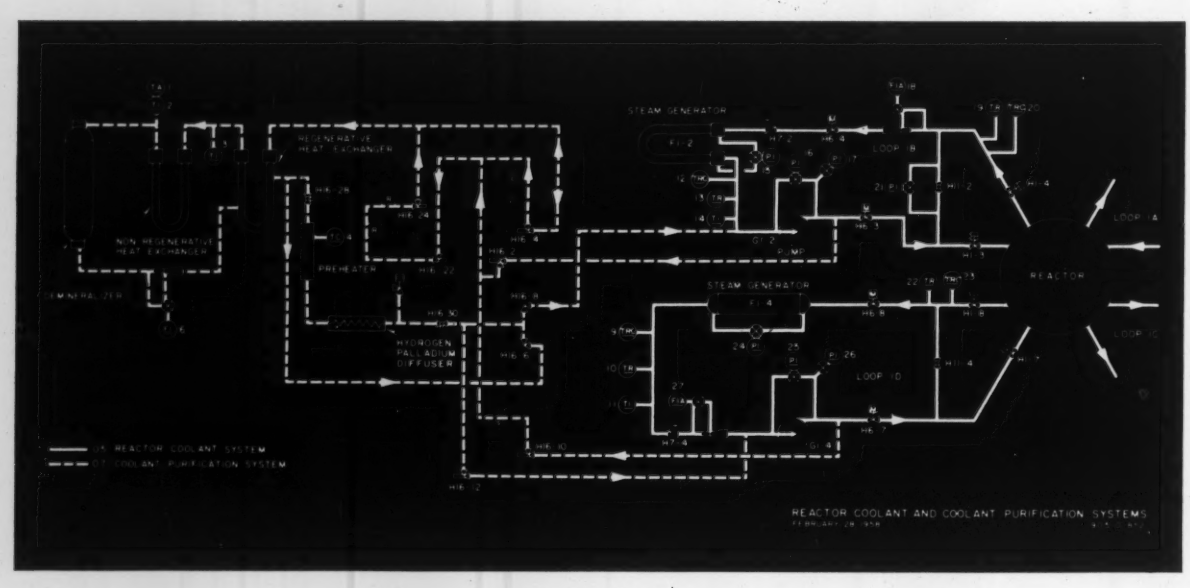

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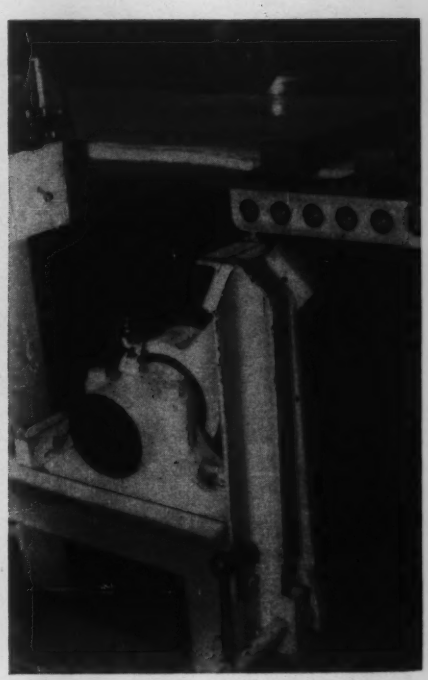

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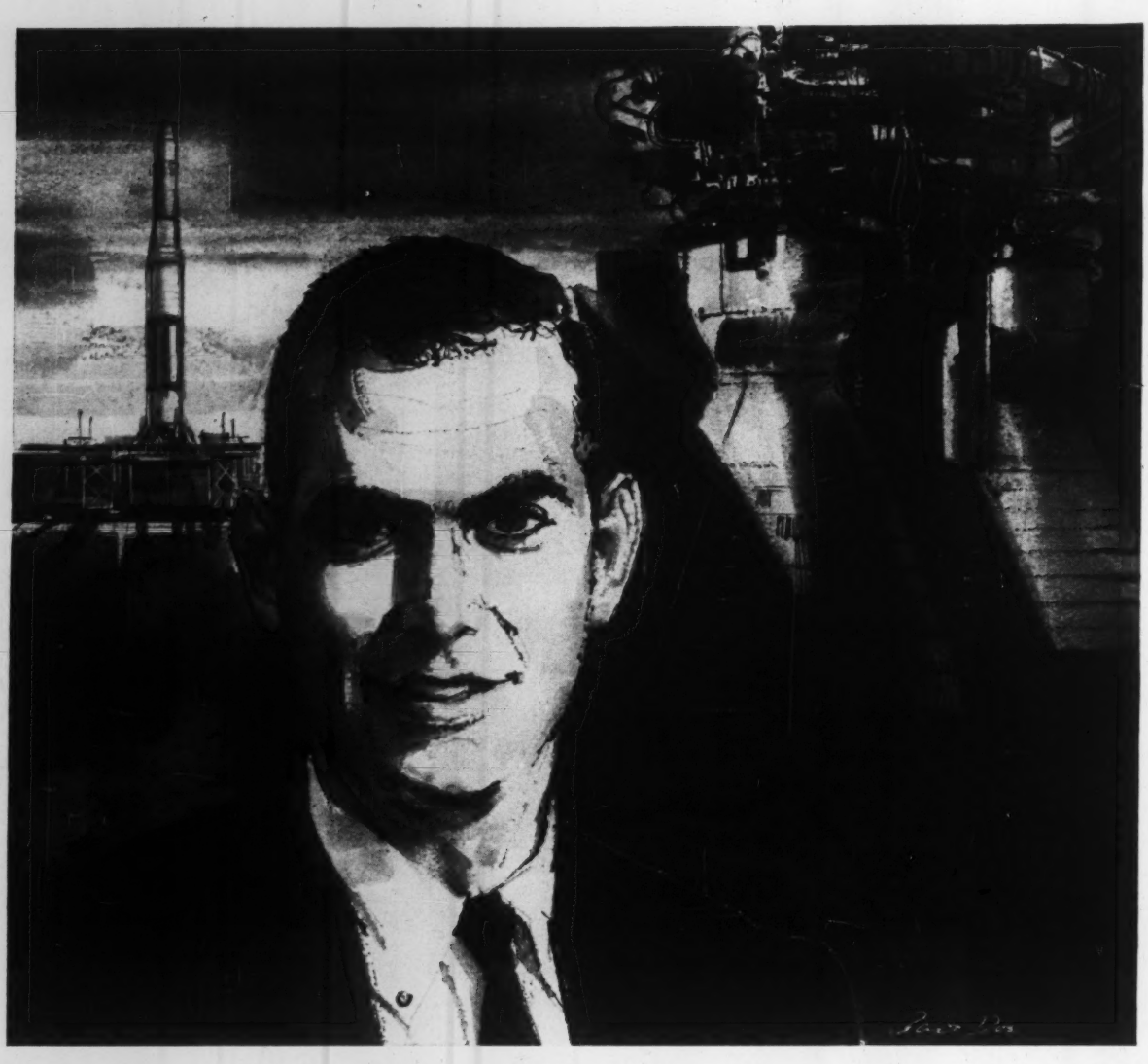

A. L. Feldman

Al Feldman is thirty-one. A Cornell BSME, he joined Aerojet as a development engineer in 1954. His present job: Head, Propulsion Systems Department, Liquid Rocket Plant, Sacramento. The assignment: design and development of rocket engines for the TITAN missile.

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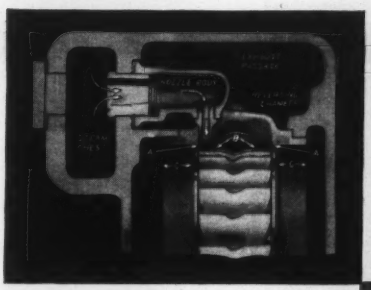

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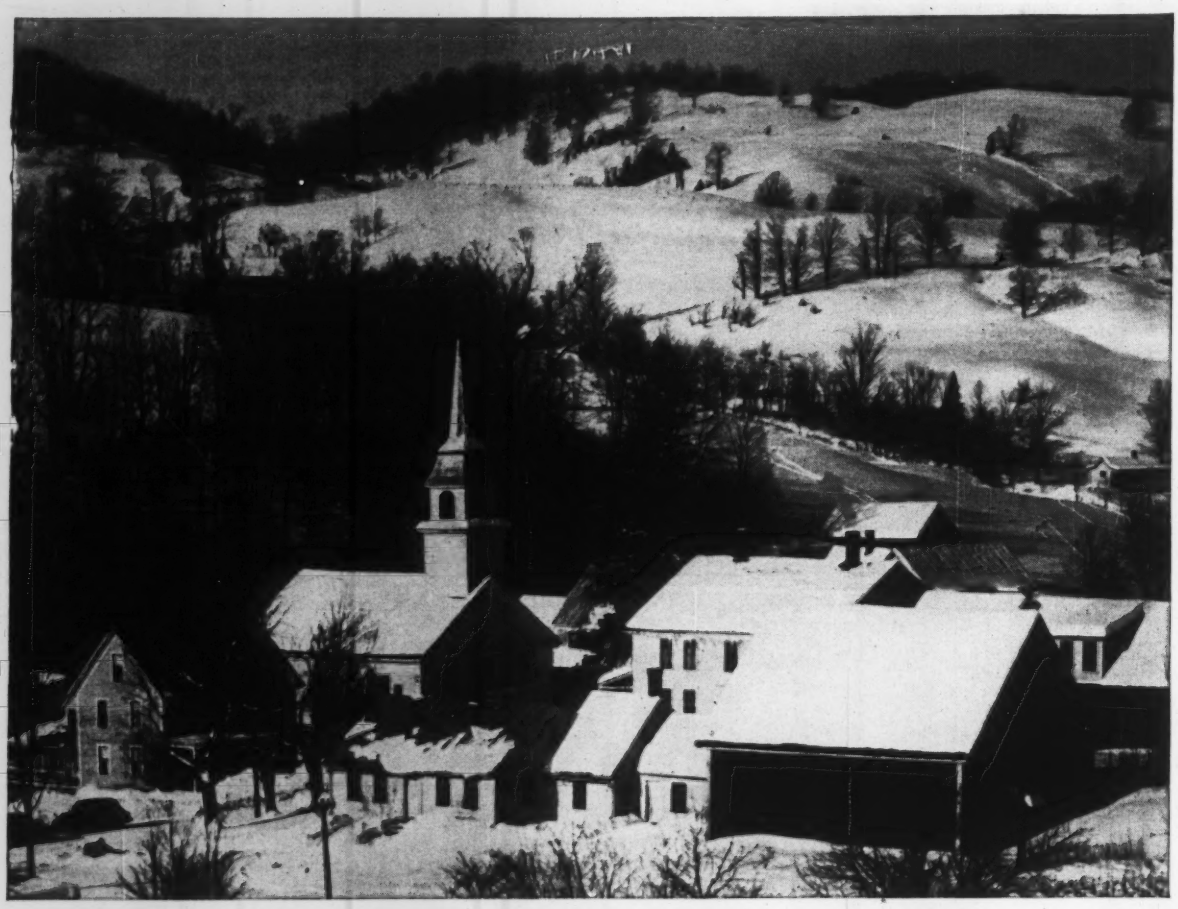

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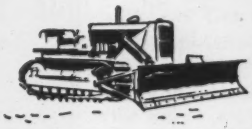

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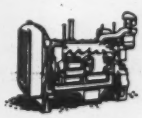

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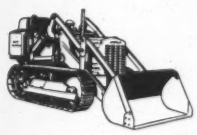

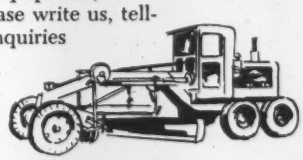

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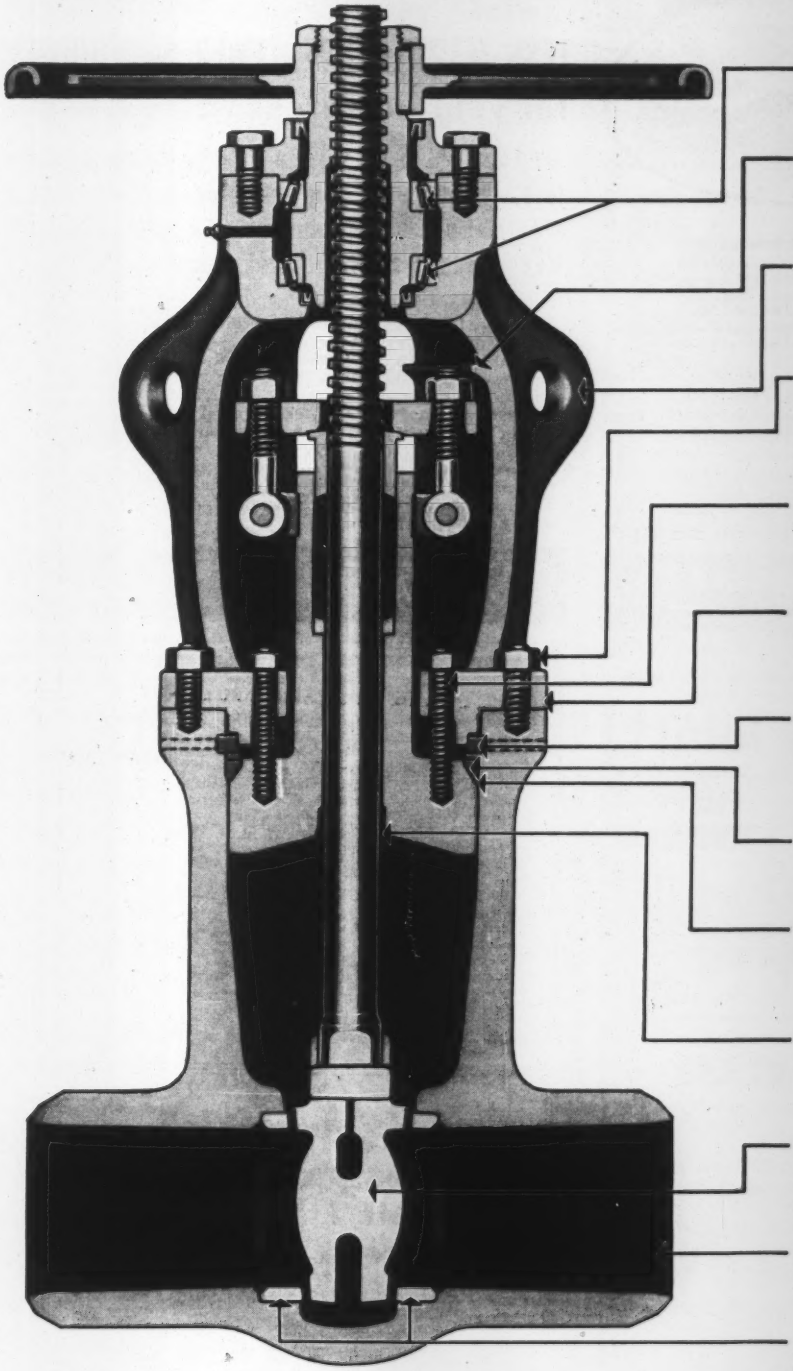

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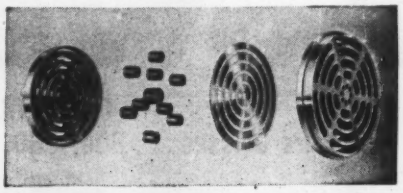

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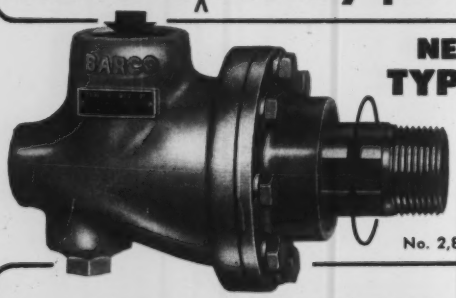

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MECHANICAL ENGINEERING
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Checking specifications and comparing notes prior to "blast-off" of unit #3 at Astoria Generating Station, Long Island, New York.

built BIG for a BIG job at Con Edison

Inspecting three of a total of 24–84" Duct Fans recently installed at Consolidated Edison's new Arthur Kill and Astoria, New York Generating Stations are a member of Con Edison's Engineering Staff and D. J. Citron, New York area representative for Aerovent.

Twelve units, rated at 100,000 cfm each, provide a total of 1,200,000 cfm to draw heat from boiler plants in both locations. In addition, eight 32" Panel Fans, rated at 10,000 cfm each, cool turbine rooms at each station. That's cooling – KING SIZE!

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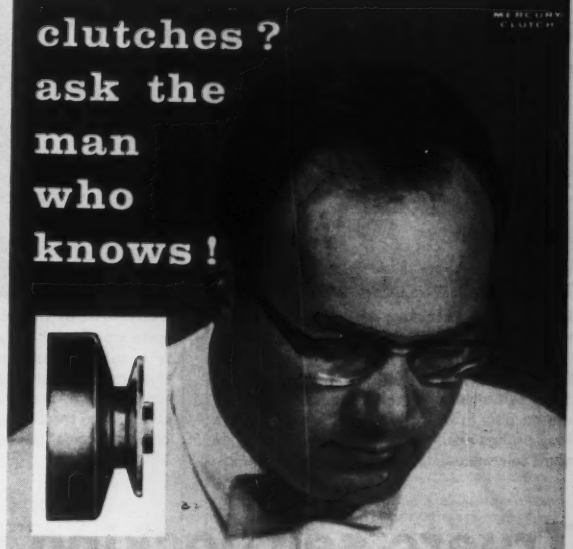
Consolidated Edison's new Arthur Kill Generating Station situated at Staten Island, New York.

clutches? ask the man who knows!



Ask a Mercury engineer; he knows clutches. Clutches are his sole stock-in-trade . . . not a sideline. From among Mercury's complete line of precision-built, standard automatic clutches (with exclusive MercoTorque action), or from over 5,000 configurations, he will come up with the perfect clutch for your job. "It's always a better design when it's drawn around a dependable Mercury Automatic Clutch." Call in a Mercury engineer.

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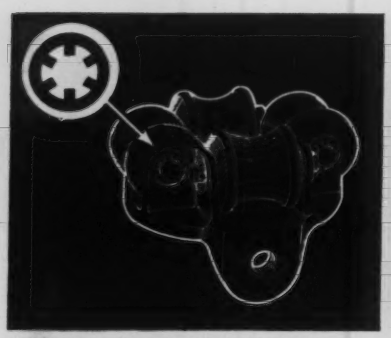
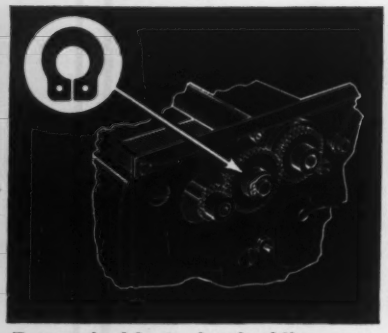
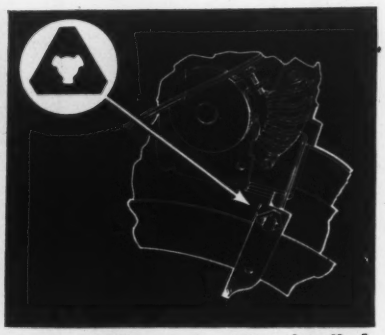


Drilling and flaring eliminated. Easier maintenance, a time saving of 50% and elimination of costly, time consuming drilling and flaring operations result when Truarc Series 5115 self-locking rings are used to retain rollers on pins in this electric cable guide. Extra long prongs enable ring to accommodate wide shaft tolerances.

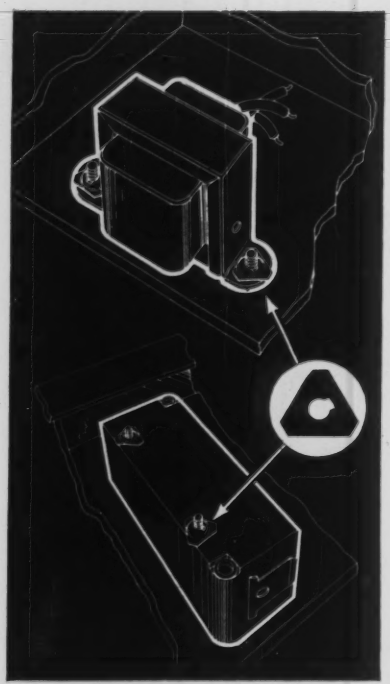


Economical fastening for idler gear. Installing Truarc Series 5555 Grip Ring flush with hub insures precise seating of gear in this portable electrocardiograph assembly. What's more, the ring eliminates a nut and costly stud-threading operation of alternate design. Typical savings amount to $365 per 1000 units.



Cross-drilling and cotter pin eliminated. Here a Truarc Series 5305 self-locking triangular retainer replaces a cotter pin used to hold an electric-motor mounting bar. Both the cotter pin and the cross-drilling operation required in the original design are eliminated. Typical total savings amount to $120 per 1000 units.

Truarc self-locking retaining rings boost economy in wide variety of designs



Easy way to mount electrical-electronic parts. Truarc Series 5300 triangular nuts replace conventional nuts and lockwashers in mounting electrical parts like transformer (top) or Microswitch (bottom). Dished body of Series 5300 flattens under torque, eliminates need for lockwasher, simplifies handling and assures assembly.

...eliminate parts, machining, speed assembly

Easy application, elimination of more expensive conventional fasteners and reduction or elimination of machining operations are just a few of the savings resulting from the proper use of self-locking retaining rings. Rings replace threaded retainers and nuts, hairpin-type cotter pins, and a variety of cut, lock, and plain washers. They require no groove, or preparatory machining operations. Rings can be installed by unskilled labor, seated at any point on the shaft, automatically taking up any accumulated tolerances.

Four ring types are shown. One has a dished triangular body which locks the fastener on the shaft under spring tension, holds under moderate shaft tolerances and against extremely heavy thrust loads. Another, a re-usable Grip Ring, is ideal for ungrooved shafts, tubes, bosses, and studs. A third type is a triangular free-spinning nut with a dished body that flattens under torque, eliminating need for separate lock washers. The fourth, a push-on type, has an arched rim to provide high strength and extra long locking prongs which accommodate wide shaft tolerances.

These are but four of the 50 functionally different types of Truarc retaining rings. They come in 740 standard sizes, 6 metal specifications, 13 different finishes. The entire Truarc line, including assembly tools, grooving tools, and 80 typical cost-saving applications, is covered in the new catalog RR 10-58. And remember, Waldes engineers are always ready to help you solve your application problems—whether they involve one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

9.15

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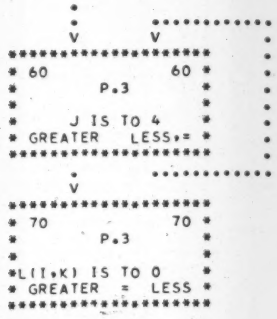

COMPUTER PROGRAMMING at IBM is being extended to include many new areas—such as orbit computation, meteorological satellites, space probes, information retrieval, design automation, real-time systems, and optical studies. As a result, we are greatly expanding our programming staff, creating opportunities for people with various levels of experience. Assignments involve a wide variety of problems in science, business and government.

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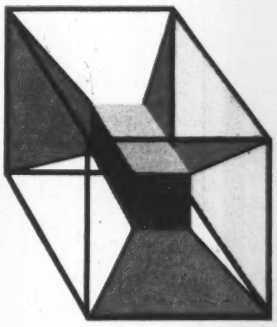

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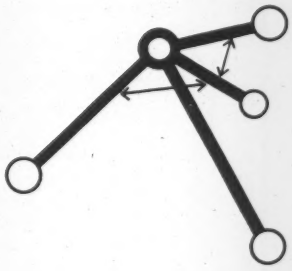

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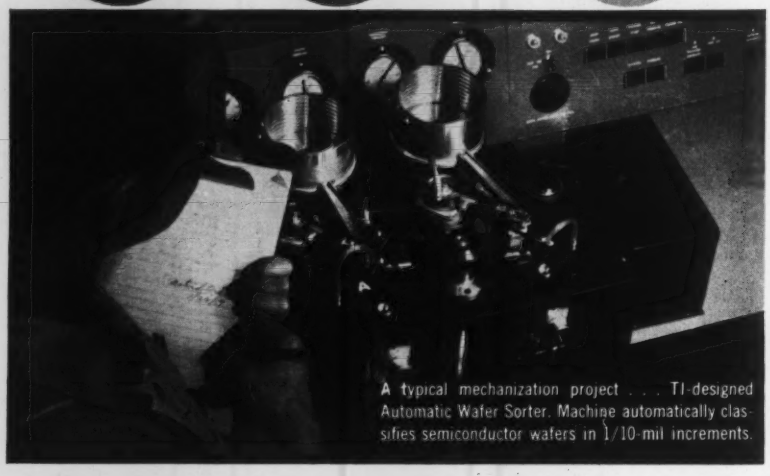

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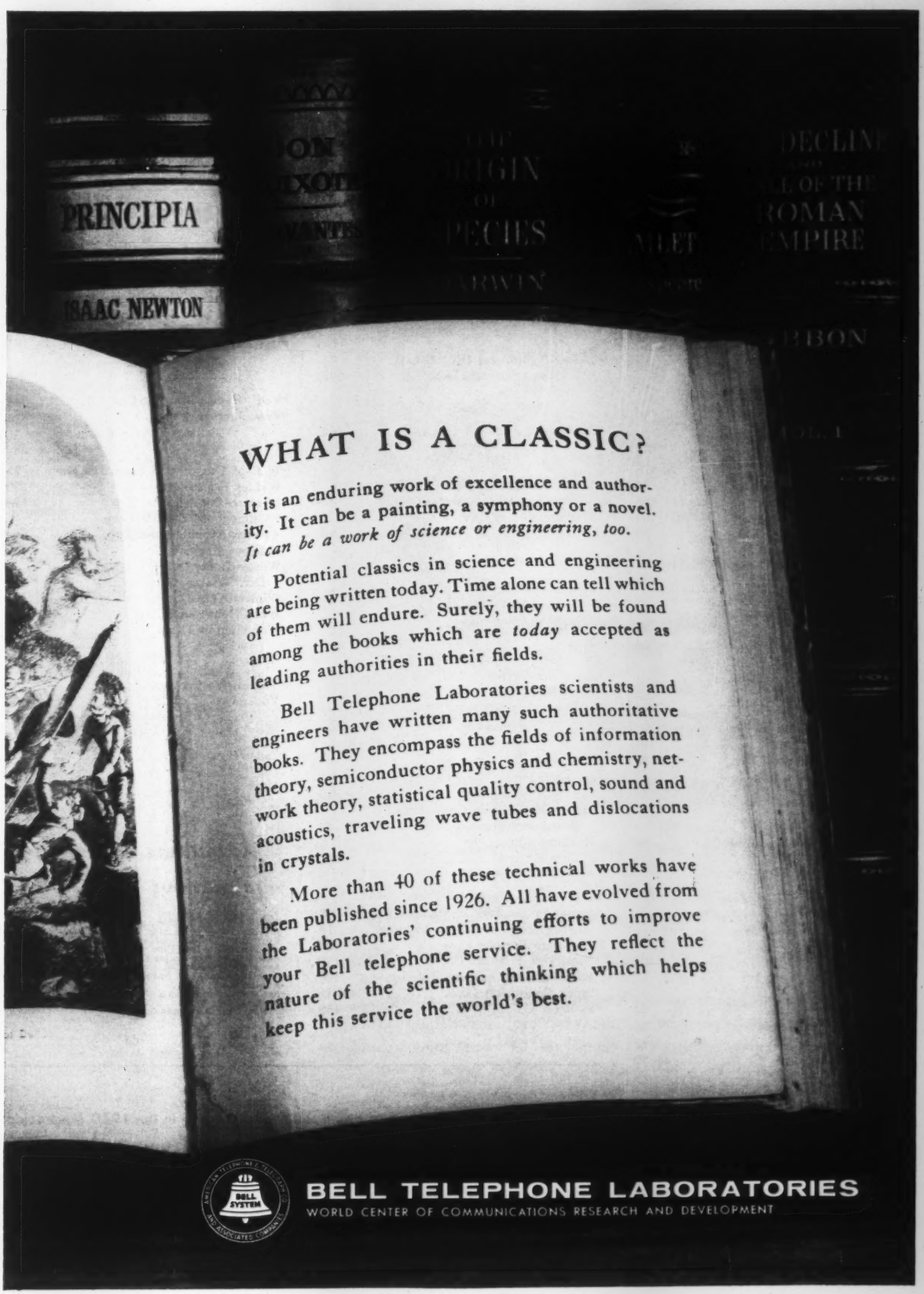
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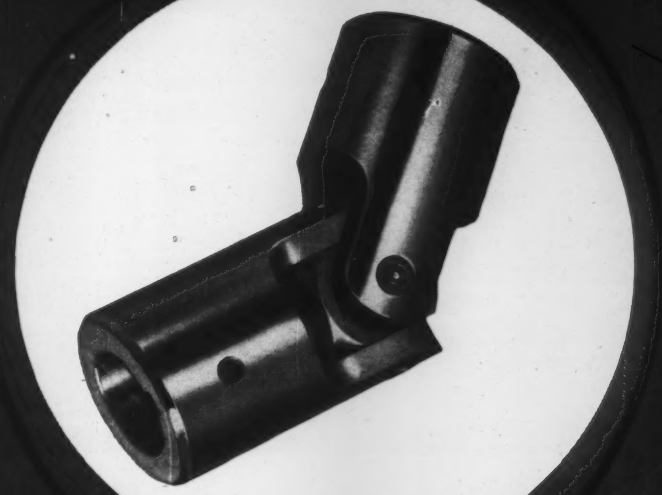

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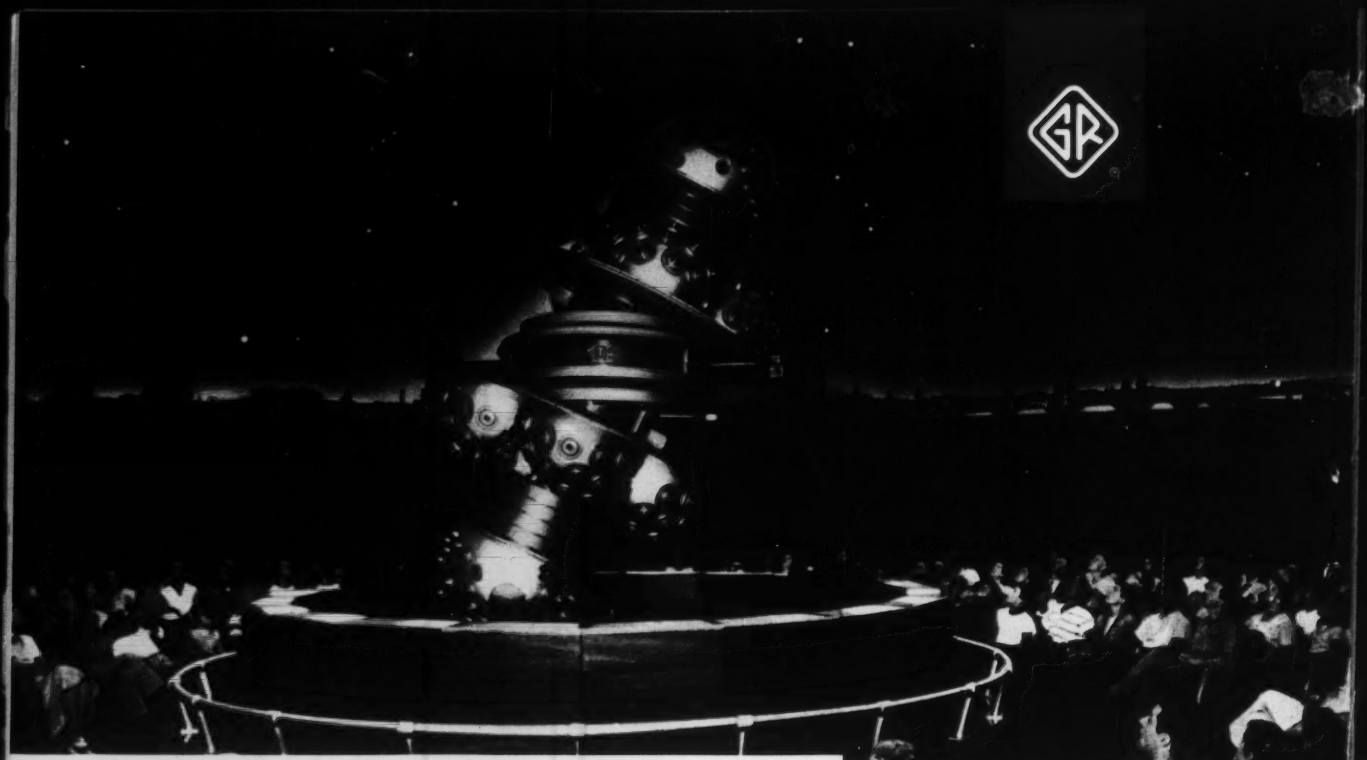


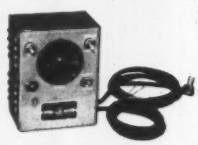
HOW Variac® MOTOR SPEED CONTROLS HELP KEEP THE SKY IN PLACE

The nation's newest and most advanced planetarium at the Museum of Science in Boston provides visitors with the most realistic star show yet devised by man. Designed and developed by the Korkosz brothers of Springfield, Massachusetts, the projector is capable of reproducing 9,600 first- to sixth-magnitude stars, each correct in brightness to one-tenth magnitude.* Viewers see the stars just as they appear out-of-doors, even to their familiar twinkle.

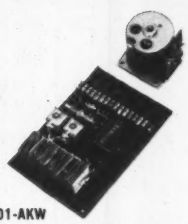
G-R Variac Motor Speed Controls position the massive three-ton projector unerringly. In this way, the sky can be adjusted to appear as seen from any spot on earth and at any time of day. Variac Motor Speed Controls were picked for this application for a number of reasons: They allow the motor to deliver maximum torque at any speed. Effective filtering of ripple currents by the Control prevents torque pulsations in the motor's output. High starting torque permits quick motor starts even under full load conditions. The Control uses no electronic tubes, insuring instant warmup and minimum maintenance. The motor can be stopped or reversed with one switch . . . dynamic braking is standard on all controls above 1/15 hp. Good regulation plus the use of a Variac continuously-adjustable autotransformer in the control make for wide-range and smo-o-o-th speed variation.

**Intensity controlled by Variac® continuously-adjustable autotransformers.*

Photograph Courtesy the Museum of Science, Boston



Type 1701-AK
1/15 hp capacity, **$85**

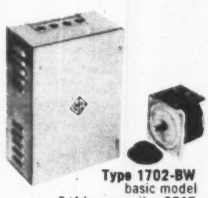


Type 1701-AKW
basic model 1/15 hp capacity, **$72**

Ten models are available for controlling d-c motors from a-c lines. Ratings range from 1/15 hp to 3/4 hp. Choice of either cabinet model, or basic stripped-down design for use as original equipment by machinery manufacturers.

Motors available
Quantity discounts apply

Type 1702-A
3/4 hp capacity, **$255**



Type 1702-BW
basic model
3/4 hp capacity, **$215**

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1922

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DR. ARTHUR KANTROWITZ. DIRECTOR
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Why Cross chose Timken® bearings for all 148 drill spindles

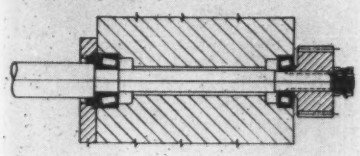
THIS huge Cross transfer machine drills and taps holes in automobile engine blocks at new highs in speed and accuracy. To assure maximum user economy and machine life, Cross engineers chose Timken® tapered roller bearings for the machine's 148 drill spindles. Here's why:

1) *They maintain precision longer.* Timken bearings are geometrically designed to give true rolling motion, precision manufactured to live up to their design.

2) *They're extra tough* because Timken bearings are made of the finest bearing-quality alloy steel available.

When you use a machine with Timken bearings, you get all the *extra* benefits of Timken Company leadership in tapered roller bearing design and in engineering service. We maintain the industry's most modern laboratory to test bearing applications. To get better machines, make sure they're Timken bearing-equipped. ***When you buy Timken bearings you get...*** *1) Quality you can take for granted. 2) Service you can't get anywhere else. 3) The best-known name in bearings. 4) The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

How THE CROSS CO. mounts 148 drill spindles of its Transfermatic machine on Timken bearings to give longer bearing life, maintain accuracy.



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